

**B.Sc HONOURS CHEMISTRY: MAJOR**

w.e.f AY 2023-24

**Course structure**

SEMESTER	Course Code	Title	Hr/ week	Credits
I	1	Essentials and applications of Mathematical, Physical and Chemical sciences	5	4
	2	Advances in Mathematical, Physical and Chemical sciences	5	4
II	3	General & Inorganic Chemistry - (T)	3	3
		General & Inorganic Chemistry - (P)	2	1
	4	Inorganic Chemistry-I - (T)	3	3
		Inorganic Chemistry-I - (P)	2	1
III	5	Fundamentals in Organic Chemistry - (T)	3	3
		Fundamentals in Organic Chemistry - (P)	2	1
	6	Organic Chemistry (Halogen & Oxygen Organic Compounds) - (T)	3	3
		Organic Chemistry (Halogen & Oxygen Organic Compounds - (P)	2	1
	7	Physical Chemistry-I ( Solutions and Electrochemistry) - (T)	3	3
		Physical Chemistry-I ( Solutions and Electrochemistry) - (P)	2	1
	8	Inorganic & Physical Chemistry - (T)	3	3

		Inorganic & Physical Chemistry - (P)	2	1
IV	9	Physical Chemistry-II (States of Matter, Phase Rule & surface Chemistry) - (T)	3	3
		Physical Chemistry-II (States of Matter, Phase Rule & surface Chemistry) - (P)	2	1
	10	General & Physical Chemistry - (T)	3	3
		General & Physical Chemistry - (P)	2	1
	11	Nitrogen containing Organic Compounds & Spectroscopy. - (T)	3	3
		Nitrogen containing Organic Compounds & Spectroscopy. - (P)	2	1
V	12 A	Analytical Methods in Chemistry-Quantitative analysis	3	3
		Analytical Methods in Chemistry-Quantitative analysis	2	1
		<b>OR</b>		
	12 B	Environmental Chemistry	3	3
		Environmental Chemistry	2	1
	13A	Chromatography and Instrumental methods of Analysis	3	3
		Chromatography and Instrumental methods of Analysis	2	1
		<b>OR</b>		
	13 B	Green Chemistry and Nanotechnology	3	3
		Green Chemistry and Nanotechnology	2	1
	14 A	Synthetic Organic Chemistry		
		Synthetic Organic Chemistry		
		<b>OR</b>		
	14 B	Industrial Chemistry- Fertilisers and Surface coatings		

		Industrial Chemistry- Fertilisers and Surface coatings		
	15 A	Analysis of Organic Compounds		
		Analysis of Organic Compounds		
		<b>OR</b>		
	15 B	Industrial Chemistry- Polymers and water analysis		
		Industrial Chemistry- Polymers and water analysis		
VI		Internship		

## I -SEMESTER

### **COURSE 1: ESSENTIALS AND APPLICATIONS OF MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES**

Hours: 5hrs/week

Credits: 4

#### **Course Objective:**

The objective of this course is to provide students with a comprehensive understanding of the essential concepts and applications of mathematical, physical, and chemical sciences. The course aims to develop students' critical thinking, problem-solving, and analytical skills in these areas, enabling them to apply scientific principles to real-world situations.

#### **Learning outcomes:**

1. Apply critical thinking skills to solve complex problems involving complex numbers, trigonometric ratios, vectors, and statistical measures.
2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations
3. To Explain the basic principles and concepts underlying a broad range of fundamental areas of chemistry and to Connect their knowledge of chemistry to daily life.
4. Understand the interplay and connections between mathematics, physics, and chemistry in various applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.
- 5 To explore the history and evolution of the Internet and to gain an understanding of network security concepts, including threats, vulnerabilities, and countermeasures.

UNIT I: ESSENTIALS OF MATHEMATICS: 9hrs

Complex Numbers: Introduction of the new symbol  $i$  – General form of a complex number – Modulus- Amplitude form and conversions

Trigonometric Ratios: Trigonometric Ratios and their relations – Problems on calculation of

angles Vectors: Definition of vector addition – Cartesian form – Scalar and vector product and problems  
Statistical Measures: Mean, Median, Mode of a data and problems

#### UNIT II: ESSENTIALS OF PHYSICS: 9hrs

Definition and Scope of Physics- Measurements and Units - Motion of objects: Newtonian Mechanics and relativistic mechanics perspective - Laws of Thermodynamics and Significance- Acoustic waves and electromagnetic waves- Electric and Magnetic fields and their interactions- Behaviour of atomic and nuclear particles- Wave-particle duality, the uncertainty principle- Theories and understanding of universe

#### UNIT III: ESSENTIALS OF CHEMISTRY: : 9hrs

Definition and Scope of Chemistry- Importance of Chemistry in daily life -Branches of chemistry and significance- Periodic Table- Electronic Configuration, chemical changes, classification of matter, Biomolecules- carbohydrates, proteins, fats and vitamins.

#### UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY: 9hrs

Applications of Mathematics in Physics & Chemistry: Calculus , Differential Equations & Complex Analysis

Application of Physics in Industry and Technology: Electronics and Semiconductor Industry, Robotics and Automation, Automotive and Aerospace Industries, Quality Control and Instrumentation, Environmental Monitoring and Sustainable Technologies.

Application of Chemistry in Industry and Technology: Chemical Manufacturing, Pharmaceuticals and Drug Discovery, Materials Science, Food and Beverage Industry.

#### UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

Milestones of computer evolution - Internet, history, Internet Service Providers, Types of Networks, IP, Domain Name Services, applications.

Ethical and social implications: Network and security concepts- Information Assurance Fundamentals, Cryptography-Symmetric and Asymmetric, Malware, Firewalls, Fraud Techniques- Privacy and Data Protection

Recommended books:

1. Functions of one complex variable by John.B.Conway, Springer- Verlag.
2. Elementary Trigonometry by H.S.Hall and S.R.Knight
3. Vector Algebra by A.R.Vasishtha, Krishna Prakashan Media(P)Ltd. 4.Basic Statistics by B.L.Agarwal, New age international Publishers
5. University Physics with Modern Physics by Hugh D. Young and Roger A. Freedman
6. Fundamentals of Physics by David Halliday, Robert Resnick, and Jearl Walker
7. Physics for Scientists and Engineers with Modern Physics" by Raymond A. Serway and John W. Jewett Jr.
8. Physics for Technology and Engineering" by John Bird
9. Chemistry in daily life by Kirpal Singh
10. Chemistry of bio molecules by S. P. Bhutan
11. Fundamentals of Computers by V. Raja Raman
12. Cyber Security Essentials by James Graham, Richard Howard, Ryan Olson

## **STUDENT ACTIVITIES**

### **UNIT I: ESSENTIALS OF MATHEMATICS:**

#### 1: Complex Number Exploration

Provide students with a set of complex numbers in both rectangular and polar forms.

They will plot the complex numbers on the complex plane and identify their properties 2:  
Trigonometric Ratios Problem Solving

Give students a set of problems that require the calculation of trigonometric ratios and their relations.

Students will solve the problems using the appropriate trigonometric functions (sine, cosine, tangent, etc.) and trigonometric identities.

### 3: Vector Operations and Applications

Provide students with a set of vectors in Cartesian form.

Students will perform vector addition and subtraction operations to find the resultant vectors.

They will also calculate the scalar and vector products of given vectors.

### 4: Statistical Measures and Data Analysis

Give students a dataset containing numerical values.

Students will calculate the mean, median, and mode of the data, as well as other statistical measures if appropriate (e.g., range, standard deviation).

They will interpret the results and analyze the central tendencies and distribution of the data.

## **UNIT II: ESSENTIALS OF PHYSICS:**

### 1. Concept Mapping

Divide students into groups and assign each group one of the topics.

Students will create a concept map illustrating the key concepts, relationships, and applications related to their assigned topic.

Encourage students to use visual elements, arrows, and labels to represent connections and interdependencies between concepts.

### 2. Laboratory Experiment

Select a laboratory experiment related to one of the topics, such as motion of objects or electric and magnetic fields.

Provide the necessary materials, instructions, and safety guidelines for conducting the experiment.

Students will work in small groups to carry out the experiment, collect data, and analyze the results.

After the experiment, students will write a lab report summarizing their findings, observations, and conclusions.

## **UNIT III: ESSENTIALS OF CHEMISTRY**

### **1: Chemistry in Daily Life Presentation**

Divide students into groups and assign each group a specific aspect of daily life where chemistry plays a significant role, such as food and nutrition, household products, medicine, or environmental issues.

Students will research and create a presentation (e.g., PowerPoint, poster, or video) that showcases the importance of chemistry in their assigned aspect.

### **2: Periodic Table Exploration**

Provide students with a copy of the periodic table.

Students will explore the periodic table and its significance in organizing elements based on their properties.

They will identify and analyze trends in atomic structure, such as electronic configuration, atomic size, and ionization energy.

### **3: Chemical Changes and Classification of Matter**

Provide students with various substances and chemical reactions, such as mixing acids and bases or observing a combustion reaction.

Students will observe and describe the chemical changes that occur, including changes in color, temperature, or the formation of new substances.

### **4: Biomolecules Investigation**

Assign each student or group a specific biomolecule category, such as carbohydrates, proteins, fats, or vitamins.

Students will research and gather information about their assigned biomolecule category, including its structure, functions, sources, and importance in the human body.

They can create informative posters or presentations to present their findings to the class.

## **UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY**



### 1: Interdisciplinary Case Studies

Divide students into small groups and provide them with interdisciplinary case studies that involve the interdisciplinary application of mathematics, physics, and chemistry.

Each case study should present a real-world problem or scenario that requires the integration of concepts from all three disciplines.

### 2: Design and Innovation Project

Challenge students to design and develop a practical solution or innovation that integrates mathematics, physics, and chemistry principles.

Students can choose a specific problem or area of interest, such as renewable energy, environmental conservation, or materials science.

### 3: Laboratory Experiments

Assign students laboratory experiments that demonstrate the practical applications of mathematics, physics, and chemistry.

Examples include investigating the relationship between concentration and reaction rate, analyzing the behavior of electrical circuits, or measuring the properties of materials.

### 4: Mathematical Modeling

Present students with real-world problems that require mathematical modeling and analysis.

## **UNIT V: ESSENTIALS OF COMPUTER SCIENCE:**

1. Identifying the attributes of network (Topology, service provider, IP address and bandwidth of
2. your college network) and prepare a report covering network architecture.
3. Identify the types of malwares and required firewalls to provide security.
4. Latest Fraud techniques used by hackers.

**I - SEMESTER**  
**COURSE 2: ADVANCES IN MATHEMATICAL, PHYSICAL AND CHEMICAL**  
**SCIENCES**

Hours: 5 hrs/week

Credits: 4

Course Objective:

The objective of this course is to provide students with an in-depth understanding of the recent advances and cutting-edge research in mathematical, physical, and chemical sciences. The course aims to broaden students' knowledge beyond the foundational concepts and expose them to the latest developments in these disciplines, fostering critical thinking, research skills, and the ability to contribute to scientific advancements.

Learning outcomes:

1. Explore the applications of mathematics in various fields of physics and chemistry, to understand how mathematical concepts are used to model and solve real-world problems.
2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations.
3. Understand the different sources of renewable energy and their generation processes and advances in nanomaterials and their properties, with a focus on quantum dots. To study the emerging field of quantum communication and its potential applications. To gain an understanding of the principles of biophysics in studying biological systems. Explore the properties and applications of shape memory materials.
3. Understand the principles and techniques used in computer-aided drug design and drug delivery systems, to understand the fabrication techniques and working principles of nanosensors. Explore the effects of chemical pollutants on ecosystems and human health.
4. Understand the interplay and connections between mathematics, physics, and chemistry in various advanced applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.
- 5 Understand and convert between different number systems, such as binary, octal, decimal, and hexadecimal. Differentiate between analog and digital signals and understand their characteristics. Gain knowledge of different types of transmission media, such as wired (e.g.,

copper cables, fiber optics) and wireless (e.g., radio waves, microwave, satellite)..

UNIT I: ADVANCES IN BASICS MATHEMATICS 9hrs

Straight Lines: Different forms – Reduction of general equation into various forms –Point of intersection of two straight lines

Limits and Differentiation: Standard limits – Derivative of a function –Problems on product rule and quotient rule

Integration: Integration as a reverse process of differentiation – Basic methods of integration

Matrices: Types of matrices – Scalar multiple of a matrix – Multiplication of matrices – Transpose of a matrix and determinants

UNIT II: ADVANCES IN PHYSICS: 9hrs

Renewable energy: Generation, energy storage, and energy-efficient materials and devices. Recent advances in the field of nanotechnology: Quantum dots, Quantum Communication- recent advances in biophysics- recent advances in medical physics- Shape Memory Materials.

UNIT III: ADVANCES IN CHEMISTRY: 9hrs

Computer aided drug design and delivery, nano sensors, Chemical Biology, impact of chemical pollutants on ecosystems and human health, Dye removal - Catalysis method

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY  
9hrs

Mathematical Modelling applications in physics and chemistry Application of Renewable energy: Grid Integration and Smart Grids, Application of nanotechnology: Nanomedicine,

Application of biophysics: Biophysical Imaging, Biomechanics, Neurophysics,

Application of medical physics: Radiation Therapy, Nuclear medicine

Solid waste management, Environmental remediation- Green Technology, Water treatment.

UNIT V: Advanced Applications of computer Science 9hrs

Number System-Binary, Octal, decimal, and Hexadecimal, Signals-Analog, Digital, Modem, Codec, Multiplexing, Transmission media, error detection and correction- Parity check and CRC, Networking devices- Repeater, hub, bridge, switch, router, gateway.

Recommended books:

1. Coordinate Geometry by S.L.Lony, Arihant Publications
2. Calculus by Thomas and Finny, Pearson Publications
3. Matrices by A.R.Vasishtha and A.K.Vasishtha, Krishna Prakashan Media(P)Ltd.
4. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
5. "Energy Storage: A Nontechnical Guide" by Richard Baxter
6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Raghvendra A. Bohara
7. "Biophysics: An Introduction" by Rodney Cotterill
8. "Medical Physics: Imaging" by James G. Webster
9. "Shape Memory Alloys: Properties and Applications" by Dimitris C. Lagoudas
10. Nano materials and applications by M.N.Borah
11. Environmental Chemistry by Anil.K.D.E.
12. Digital Logic Design by Morris Mano
13. Data Communication & Networking by Bahrouz Forouzan.

## STUDENT ACTIVITIES

### UNIT I: ADVANCES IN BASIC MATHEMATICS

#### 1: Straight Lines Exploration

Provide students with a set of equations representing straight lines in different forms, such as slope-intercept form, point-slope form, or general form.

Students will explore the properties and characteristics of straight lines, including their slopes, intercepts, and point of intersection.

## 2: Limits and Differentiation Problem Solving

Students will apply the concept of limits to solve various problems using standard limits.

Encourage students to interpret the results and make connections to real-world applications, such as analyzing rates of change or optimizing functions.

## 3: Integration Exploration

Students will explore the concept of integration as a reverse process of differentiation and apply basic methods of integration, such as the product rule, substitution method, or

integration by parts.

Students can discuss the significance of integration in various fields, such as physics and chemistry

## 4: Matrices Manipulation

Students will perform operations on matrices, including scalar multiplication, matrix multiplication, and matrix transpose.

Students can apply their knowledge of matrices to real-world applications, such as solving systems of equations or representing transformations in geometry.

## UNIT II: ADVANCES IN PHYSICS:

### 1: Case Studies

Provide students with real-world case studies related to renewable energy, nanotechnology, biophysics, medical physics, or shape memory materials.

Students will analyze the case studies, identify the challenges or problems presented, and propose innovative solutions based on the recent advances in the respective field.

They will consider factors such as energy generation, energy storage, efficiency, sustainability, materials design, biomedical applications, or technological advancements.

## 2: Experimental Design

Assign students to design and conduct experiments related to one of the topics: renewable energy, nanotechnology, biophysics, medical physics, or shape memory materials.

They will identify a specific research question or problem to investigate and design an experiment accordingly.

Students will collect and analyze data, interpret the results, and draw conclusions based on their findings.

They will discuss the implications of their experimental results in the context of recent advances in the field.

## 3: Group Discussion and Debate

Organize a group discussion or debate session where students will discuss the ethical, social, and environmental implications of the recent advances in renewable energy, nanotechnology, biophysics, medical physics, and shape memory materials.

Assign students specific roles, such as proponent, opponent, or moderator, and provide them with key points and arguments to support their positions.

## UNIT III: ADVANCES IN CHEMISTRY:

### 1. Experimental Design and Simulation

In small groups, students will design experiments or simulations related to the assigned topic.

For example, in the context of computer-aided drug design, students could design a virtual screening experiment to identify potential drug candidates for a specific disease target.

For nano sensors, students could design an experiment to demonstrate the sensitivity and selectivity of nano sensors in detecting specific analytes.

Chemical biology-related activities could involve designing experiments to study enzyme-substrate interactions or molecular interactions in biological systems.

Students will perform their experiments or simulations, collect data, analyze the results, and draw conclusions based on their findings.

## 2. Case Studies and Discussion

Provide students with real-world case studies related to the impact of chemical pollutants on ecosystems and human health.

Students will analyze the case studies, identify the sources and effects of chemical pollutants, and propose mitigation strategies to minimize their impact.

Encourage discussions on the ethical and environmental considerations when dealing with chemical pollutants.

For the dye removal using the catalysis method, students can explore case studies where catalytic processes are used to degrade or remove dyes from wastewater.

Students will discuss the principles of catalysis, the advantages and limitations of the catalysis method, and its applications in environmental remediation.

## 3: Group Project

Assign students to work in groups to develop a project related to one of the topics.

The project could involve designing a computer-aided drug delivery system, developing a nano sensor for a specific application, or proposing strategies to mitigate the impact of chemical pollutants on ecosystems.

Students will develop a detailed project plan, conduct experiments or simulations, analyze data, and present their findings and recommendations.

Encourage creativity, critical thinking, and collaboration throughout the project.

## UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

### 1: Mathematical Modelling Experiment

Provide students with a mathematical modelling experiment related to one of the topics. For example, in the context of renewable energy, students can develop a mathematical model to optimize the placement and configuration of solar panels in a solar farm.

Students will work in teams to design and conduct the experiment, collect data, and analyze the results using mathematical models and statistical techniques.

They will discuss the accuracy and limitations of their model, propose improvements, and interpret the implications of their findings in the context of renewable energy or the specific application area.

## 2: Case Studies and Group Discussions

Assign students to analyze case studies related to the applications of mathematical modelling in nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.

Students will discuss the mathematical models and computational methods used in the case studies, analyze the outcomes, and evaluate the effectiveness of the modelling approach.

Encourage group discussions on the challenges, ethical considerations, and potential advancements in the field.

Students will present their findings and engage in critical discussions on the advantages and limitations of mathematical modelling in solving complex problems in these areas.

## 3. Group Project

Assign students to work in groups to develop a group project that integrates mathematical modelling with one of the application areas: renewable energy, nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.

The project could involve developing a mathematical model to optimize the delivery of radiation therapy in medical physics or designing a mathematical model to optimize waste management practices.

Students will plan and execute their project, apply mathematical modelling techniques, analyze the results, and present their findings and recommendations.

Encourage creativity, critical thinking, and collaboration throughout the project.

UNIT V: Advanced Applications of computer Science



1. Students must be able to convert numbers from other number system to binary number systems
2. Identify the networking media used for your college network
3. Identify all the networking devices used in your college premises.

## II - SEMESTER

### Course Code 3: GENERAL AND INORGANIC CHEMISTRY

Credits: 03

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**Course Outcomes:** At the end of the course the student will be able to-

1. Understand the structure of atom and the arrangement of elements in the periodic table.
2. Understand the nature and properties of ionic compounds.
3. Identify the structure of a given inorganic compound.
4. Explain the existence of special types of compounds through weak chemical forces.
5. Define acids and bases and predict the nature of salts.

#### Syllabus:

##### Unit I: Atomic Structure and Periodic table (9 h)

Electronic configuration: Bohr theory, dual nature of electrons, Heisenberg uncertainty principle, the Schrodinger equation, significance of wave functions, normalization of wave function, radial and angular wave functions, Pauli's exclusion principle, Hund's rule, sequence of energy levels (Aufbau principle).

Periodicity: periodic law and arrangement of elements in the periodic table, IUPAC nomenclature and group number, horizontal, vertical, and diagonal relationships in the periodic table. 1.3 General properties of atoms: size of atoms and ions-atomic radii, ionic radii, covalent radii; trend in ionic radii, ionization potential, electron affinity; electronegativity - Pauling, Mulliken-Jaffe, Allred-Rochow definitions; oxidation states and variable valency; isoelectronic relationship; inert-pair effect;

##### UNIT 2: Ionic bond (9 h)

Properties of ionic compounds, factors favouring the formation of ionic compounds- ionization potential, electron affinity, and electronegativity. Lattice energy: definition, factors affecting lattice energy, Born-Haber cycle-enthalpy of formation

of ionic compound and stability. Stability of ionic compounds in terms of  $\Delta H_f$  and  $U_o$ . Solubility and thermal stability of ionic compounds. Covalent character in ionic compounds-polarization and Fajan's rules; effects of polarization-solubility, melting points, and thermal stability of typical ionic compounds.

### **UNIT 3: The Covalent Bond (9 h)**

Valence Bond theory-arrangement of electrons in molecules, hybridization of atomic orbitals and geometry of molecules- $\text{BeCl}_2$ ,  $\text{BF}_3$ ,  $\text{CH}_4$ ,  $\text{PCl}_5$ ,  $\text{SF}_6$ - VSEPR model-effect of bonding and nonbonding electrons on the structure of molecules, effect of electronegativity,

isoelectronic principle, illustration of structures by VSEPR model- $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{SF}_4$ ,  $\text{ICl}_4^-$ ,  $\text{ICl}_2^-$ ,  $\text{XeF}_4$ ,  $\text{XeF}_6$

Molecular orbital theory -LCAO method, construction of M.O. diagrams for homo-nuclear and hetero-nuclear diatomic molecules ( $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{CO}$  and  $\text{NO}$ )

### **UNIT 4: Metallic and Weak Bonds (9 h)**

The Metallic bond: metallic properties, free electron theory, Valence Bond Theory, band theory of metals. Explanation of conductors, semiconductors and insulators.

Weak bonds: hydrogen bonding-intra- and intermolecular hydrogen bonding, influence on the physical properties of molecules, comparison of hydrogen bond strength and properties of hydrogen bonded N, O and F compounds; associated molecules-ethanol and acetic acid; Vanderwaals forces, ion dipole-dipole interactions.

### **UNIT 5: Acids and Bases (9 h)**

Theories of acids and bases: Arrhenius theory, Bronsted-Lowry theory, Lewis theory, the solvent system, Nonaqueous solvents: classification-protonic and aprotic solvents, liquid ammonia as solvent-solutions of alkali and alkaline earth metals in ammonia.

Types of chemical reactions: acid-base, oxidation-reduction, calculation of oxidation

number. Definition of pH,  $pK_a$ ,  $pK_b$ . Types of salts, Salt hydrolysis. Pearson's concept, HSAB principle & its importance, bonding in Hard-Hard and Soft-Soft combinations.

**List of Reference Books:**

1. J. D. Lee, Concise Inorganic Chemistry, 5<sup>th</sup> ed., Blackwell Science, London, 1996.
2. . B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 1996.
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3<sup>rd</sup> ed., W. H. Freeman and Co, London,

## II - SEMESTER

### Course Code 3: GENERAL AND INORGANIC CHEMISTRY

Credits: 01

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#### Practical- I Qualitative Analysis of SIMPLE SALT

Qualitative inorganic analysis (Minimum of Six simple salts should be analysed) 50 M

##### I. Course outcomes:

At the end of the course, the student will be able to;

1. Understand the basic concepts of qualitative analysis of inorganic simple salt.
2. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
3. Apply the concepts of common ion effect, solubility product and concepts related to qualitative analysis

##### II. Laboratory course

**syllabus: Analysis of SIMPLE SALT 50 M**

Analysis of simple salt containing ONE anion and ONE cation from the following:

Anions: Carbonate, Sulphate, Chloride, Bromide, Acetate, Nitrate, Borate, Phosphate. Cations: Lead, Copper, Iron, Aluminium, Zinc, Nickel, Manganese, Calcium, Strontium, Barium, Magnesium and Ammonium.

#### Co-curricular activities and Assessment Methods

1. Continuous Evaluation: Monitoring the progress of student's learning.
2. Class Tests, Work sheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions:  
Enhances critical thinking skills and personality
4. SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER

**Reference books:**

1. Vogel's Quantitative Inorganic Analysis, Seventh edition, Pearson.

## II - SEMESTER

### Course Code 4: INORGANIC CHEMISTRY- I

Credits: 03

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#### Course outcomes:

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

1. Understand the basic concepts of p-block elements.
2. Explain the concepts of d-block elements
3. Distinguish lanthanides and actinides.
4. Describe the importance of radioactivity.

#### Syllabus:

##### UNIT –I Chemistry of p-block elements – I 9 h

Group 13: Preparation & structure of Diborane, Borazine and (BN)<sub>x</sub> Group14: Preparation, classification and uses of silicones and Silanes. Group 15: Preparation & structure of Phosphonitric Chloride P<sub>3</sub>N<sub>3</sub>Cl<sub>6</sub>

##### Unit II Chemistry of p-block elements – II 9 h

Group 16: Classification of Oxides, structures of oxides and Oxoacids of Sulphur Group 17: Preparation and Structures of Interhalogen compounds. Pseudohalogens,

##### UNIT-III Chemistry of d-block elements: 9 h

Characteristics of d-block elements with special reference to electronic configuration, variable valence, colour, magnetic properties, catalytic properties and ability to form complexes. Stability of various oxidation states of 3d series-Latimer diagrams.

##### UNIT-IV Chemistry of f-block elements: 9 h

Chemistry of lanthanides - electronic configuration, oxidation states, lanthanide contraction, consequences of lanthanide contraction, colour, magnetic properties.

Separation of lathanides by ion exchange method.

Chemistry of actinides - electronic configuration, oxidation states, actinide contraction, comparison of lanthanides and actinides.

### **Unit – V Radioactivity 9 h**

Definition, Isotopes, n/p ratio, binding energy, types of radioactivity, Soddy-Fajan's displacement law, Law of Radioactivity, Radioactive decay series, Nuclear Reactions- fission and fusion, Applications of radioactivity.

#### **List of Reference books:**

1. Basic Inorganic Chemistry by Cotton and Wilkinson
2. Advance Inorganic chemistry vol-I by Satya Prakash
3. Inorganic chemistry by Puri and Sharma
4. Concise Inorganic Chemistry by J D Lee
5. Nuclear Chemistry by Maheshwar Sharon, 2009

## **II -SEMESTER**

### **Course Code 4: INORGANIC CHEMISTRY- I**

**Credits: 01**

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#### **Course outcomes:**

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

1. Understand the basic concepts of inorganic preparations.
2. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
3. Apply the properties of various elements for the preparation of inorganic compounds.

#### **Syllabus:**



### **Preparation of Inorganic compounds:**

4. Crystallization of compounds and determination of melting point.
5. Preparation of Cuprous chloride.
6. Preparation of Potash Alum.
7. Preparation of Chrome Alum.
8. Preparation of Ferrous oxalate
9. Preparation of Ferrous ammonium sulphate.

### **Co-curricular activities and Assessment Methods**

10. Continuous Evaluation: Monitoring the progress of student's learning
11. Class Tests, Worksheets and Quizzes
12. Presentations, Projects and Assignments and Group Discussions:  
Enhances critical thinking skills and personality
13. SEMESTER -End Examination: critical indicator of student's learning  
and teaching methods adopted by teachers throughout the  
SEMESTER .

### **Reference books:**

1. Vogel's Quantitative Inorganic Analysis, Seventh edition, Pearson.

### III -SEMESTER

#### Course Code 5: FUNDAMENTALS IN ORGANIC CHEMISTRY

Credits: 03

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#### Course outcomes:

At the end of SEMESTER the student will be able to

1. Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
3. Learn and identify many organic reaction mechanisms .
4. Correlate and describe the stereo-chemical properties of organic compounds and reactions.

#### Syllabus:

##### Unit 1. Structural theory in Organic Chemistry (9 h)

Types of bond fission and organic reagents (Electrophilic, Nucleophilic, and free radical reagents). Reaction intermediates – Carbocations, carbanions & free radicals. Bond polarization: Factors influencing the polarization of covalent bonds, inductive effect - Application of inductive effect (a) Basicity of amines (b) Acidity of carboxylic acids (c) Stability of carbonium ions. Resonance or Mesomeric effect, application to (a) acidity of phenol, and (b) acidity of carboxylic acids. Hyper conjugation and its application to stability of carbonium ions, Free radicals and alkenes.

##### Unit II Saturated Hydrocarbons (Alkanes and Cycloalkanes) 9 h

General methods of preparation of alkanes- Wurtz and Wurtz Fittig reaction, Corey House synthesis, physical and chemical properties of alkanes, Conformational analysis of alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane).

General molecular formulae of cycloalkanes and relative stability, Baeyer strain theory, Cyclohexane conformations with energy diagram, Conformations of monosubstituted cyclohexane.

### **UNIT-III Unsaturated Hydrocarbons (Alkenes and Alkynes) 9 h**

General methods of preparation, physical and chemical properties, Saytzeff and Hoffmann eliminations (with mechanism), Electrophilic Additions, ( $H_2$ , HX) mechanism (Markownikoff/ Antimarkownikoff addition) with suitable examples-syn and anti-addition;

addition of  $X_2$ , HX. Oxymercuration demercuration, ozonolysis, hydroxylation, Diels Alder reaction, 1,2- and 1,4-addition reactions in conjugated dienes. Reactions of alkynes; acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, Alkylation of terminal alkynes.

#### **UNIT-IV Benzene and its reactivity (9 h )**

Structure of Benzene – Preparation - polymerisation of acetylene and decarboxylation- Properties -mechanism of electrophilic aromatic substitution of Friedel- Craft's alkylation and acylation. halogenation and nitration,

#### **UNIT-V Orientation of aromatic substitution (9 h )**

Concept of aromaticity, Huckel's rule - application to Benzenoid (Benzene, Naphthalene) and Non - Benzenoid compounds (cyclopropenylcation, cyclopentadienyl anion and tropylium cation) Orientation of aromatic substitution - ortho, para and meta directing groups. Ring activating and deactivating groups with examples (Electronic interpretation of various groups like NO<sub>2</sub> and Phenolic). Orientation of (i) Amino, methoxy and methyl groups (ii) Carboxy, nitro, nitrile, carbonyl and sulphonic acid groups (iii) Halogens.

#### **II. List of Reference Books**

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Guide book to Mechanism in Organic Chemistry by Peter Sykes 6<sup>th</sup> edition, 1985.

## Course Code 5: Organic Qualitative analysis

Credits: 01

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### Organic Qualitative analysis

#### Course outcomes:

At the end of the course, the student will be able to;

1. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
2. Determine melting and boiling points of organic compounds
3. Understand the application of concepts of different organic reactions studied in theory part of organic chemistry

#### Syllabus:

Analysis of an organic compound through systematic qualitative procedure for functional group identification including the determination of melting point and boiling point with suitable derivatives. Alcohols, Phenols, Aldehydes, Ketones, Carboxylic acids, Aromatic primary amines, amides and simple sugars.

#### Co-curricular activities and Assessment Methods

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions:  
Enhances critical thinking skills and personality
4. SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

#### Reference books:

- 1) Vogel A.I .Practical Organic Chemistry, Longman Group Ltd.

- 2) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 3) Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.

### III -SEMESTER

#### Course Code 6: ORGANIC CHEMISTRY

(Halogen and Oxygen containing organic compounds)

Credits: 03

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#### Course outcomes:

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

1. Understand the concept of  $SN_1$  and  $SN_2$  and  $SN_i$  mechanisms.
2. Describe the reactivity of alcohols and phenols.
3. Achieve the skills required to propose various mechanisms
4. Apply the concepts for synthesising various oxygen containing organic compounds
5. Interconvert the monosaccharides.

#### Syllabus:

##### Unit – I Halogen compounds ( 9 h)

**Alkyl halides:** Preparation of alkyl halides from i) alkanes, ii) alkenes and iii) alcohols. Properties - nucleophilic substitution reactions— $SN_1$  and  $SN_2$  and  $SN_i$  mechanisms with energy profile diagrams, stereo chemical aspects and effect of solvent. Williamson's synthesis.

**Aryl halides:** Preparation i) from phenols ii) Sandmeyer's reaction, nucleophilic aromatic substitution (Benzyne mechanism); relative reactivity of alkyl, allyl, vinyl and benzyl, aryl halides towards nucleophilic substitution reactions.

##### Unit II Alcohols and Phenols ( 9 h )

**Alcohols:** Preparation of  $1^\circ, 2^\circ, 3^\circ$  alcohols from Grignard's reagent, Bouveault–Blanc Reduction; Chemical properties – substitution of  $-OH$  by using  $PCl_5$ ,  $PCl_3$ ,  $PBr_3$ ,  $SOCl_2$  and with  $HX / ZnCl_2$ , Oxidation of alcohols with PCC, PDC; Oxidation of diols by  $HIO_4$  and  $Pb(OAc)_4$ , Pinacol Pinacolone arrangement with mechanism, relative reactivity of  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  alcohols.

**Phenols :** Preparation from diazonium salt and Cumene. Reactions and mechanism—Reimer–Tiemann, Kolbe–Schmitt Reactions, Fries and Claisen rearrangements.

### **Unit III Carbonyl Compounds ( 9 h )**

Preparation from-Acid chlorides,1,3-dithiane and nitriles; Structure and reactivity of carbonyl group, Nucleophilic addition reactions with HCN, NaHSO<sub>3</sub> and alcohols. addition-

elimination reactions with hydroxylamine, hydrazine, phenyl hydrazine, 2,4DNP, semicarbazide. Oxidations and reductions (Clemmensen's, Wolf-Kishner's, with LiAlH<sub>4</sub> & NaBH<sub>4</sub>).

**Reaction & Mechanism-** Aldol condensation, Cannizzaro reaction, Perkin reaction, Benzoin condensation, Claisen-Schmidt reaction, Haloform reaction

### **Unit-IV Carboxylic acid and Active methylene Compounds (9h )**

**Carboxylic Acids:** Preparation from Grignard reagent and hydrolysis of nitriles, Reactions of monocarboxylic acids- Reactions involving -H, -OH and -COOH groups, formation of salts, esters, acid chlorides, amides and anhydrides. Degradation of carboxylic acids by Hunsdiecker's reaction, decarboxylation by Schmidt reaction, Arndt-Eistert synthesis, halogenation by Hell- Volhard- Zelinsky reaction. Mechanisms of acidic and alkaline hydrolysis of esters, Reformatsky reactions, Curtius rearrangement.

**Active methylene compounds:** Ketoenol tautomerism, preparation of Aceto Acetic Ester(AAE) by Claisen condensation with mechanism, synthetic applications of AAE in the preparation of mono carboxylic acids, di carboxylic acids,  $\alpha,\beta$ -unsaturated acids and heterocyclic compounds.

### **Unit V : Carbohydrates ( 9 h )**

Classification and their biological importance, Monosaccharides: Structural elucidation of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides—Haworth structure of maltose, lactose and sucrose.



## II. List of Reference Books

- 1) 1.Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 2) 2.Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 3) Guide book to Mechanism in Organic Chemistry by Peter Sykes 6<sup>th</sup> edition, 1985.

## III - SEMESTER

### Course Code 6: Organic preparations

Credits: 01

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#### Organic preparation

##### Course outcomes:

On the completion of the course, the student will be able to do the following:

1. How to use glassware, equipment and chemicals and follow experimental procedures in the laboratory.
2. How to calculate limiting reagent, theoretical yield, and percent yield.
3. How to perform common laboratory techniques including reflux, distillation, recrystallization, vacuum filtration.
4. How to critically evaluate data collected to determine the identity, purity and percent yield of products and to summarize findings in writing in a clear and concise manner.

##### Syllabus - Organic preparations (50M)

- i. Acetylation of  $\beta$ -naphthol, vanillin and salicylic acid by:
  - a) Using conventional method.
  - b) Using green approach

- ii. Preparation of Nerolin

**Co-curricular activities and Assessment Methods;**

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions:  
Enhances critical thinking skills and personality
4. SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

**Reference books:**

1. Vogel A.I .Practical Organic Chemistry, Longman Group Ltd.
2. Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
3. Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.

### III - SEMESTER

#### Course Code 7: PHYSICAL CHEMISTRY - I

#### (Solutions & Electro Chemistry)

Credits: 03

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#### Course outcomes:

At the end of the SEMESTER the student will be able to

1. Understand the ideal and non ideal behaviour of solutions.
2. Determine the molecular mass of non-volatile solutes.
3. Discuss the basic concepts of Photochemistry.
4. Apply the principles of electrical conductivity.
5. Explain the importance of emf and its applications.

#### Syllabus:

##### Unit I Solutions (9 h)

Classification - Miscible, Partially miscible and Immiscible - Raoult's Law - Azeotropes- HCl-H<sub>2</sub>O system and ethanol-water system. Partially miscible liquids-phenol- water system. Critical solution temperature (CST), Effect of impurity on consulate temperature. Immiscible liquids and steam distillation. Nernst distribution law. Calculation of the partition coefficient. Applications of distribution law.

##### Unit II Colligative Properties (9 h)

Relative lowering of Vapour Pressure, Elevation in boiling point depression in freezing point and Osmotic pressure. Determination of molecular mass of non-volatile solute by Ostwald-Walker method, Cottrell's method, Rast method and Barkeley-Hartley method.

Abnormal colligative properties. Van't Hoff factor.

##### Unit III – Photochemistry (9h)

Difference between thermal and photochemical processes, Laws of photochemistry-

Grothus- Draper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield- Photochemical reaction mechanism- hydrogen- chlorine and hydrogen- bromine reaction. Qualitative description of fluorescence, phosphorescence, Jablonski diagram, chemiluminescence - Photosensitized reactions- energy transfer processes (simple example), quenching, Photo stationary state.

#### **Unit IV Electrochemistry-I ( 9 h )**

Conductance, Specific conductance, equivalent conductance and molar conductance - effect of dilution. Cell constant. Strong and weak electrolytes, Kohlrausch's law and its applications, Definition of transport number, determination of transport number by Hittorf's method. Debye-Huckel - Onsagar's equation for strong electrolytes (derivation excluded), Application of conductivity measurements- conductometric titrations.

#### **Unit V Electrochemistry-II ( 9 h )**

Electrochemical Cells- Single electrode potential, Types of electrodes with examples: Metal-metal ion, Gas electrode, Inert electrode, Redox electrode, Metal-metal insoluble salt- salt anion. Determination of EMF of a cell, Nernst equation, Applications of EMF measurements -Potentiometric titrations. Fuelcells – Basic concepts, examples and applications.

#### **List of Reference books:**

- 1) Principles of physical chemistry by Prutton and Marron
- 2) Solid State Chemistry and its applications by Anthony R. West
- 3) Text book of physical chemistry by K L Kapoor
- 4) Text book of physical chemistry by S Glasstone
- 5) Advanced physical chemistry by Bahl and Tuli
- 6) Advanced physical chemistry by Gurudeep Raj
- 7) Principles of physical chemistry by Puri, Sharma and Pathania.

### III - SEMESTER

#### Course Code 7: PHYSICAL CHEMISTRY -I

Credits: 01

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#### PHYSICAL CHEMISTRY

##### I. Course outcomes:

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

1. Use of glassware, equipment and chemicals and follow experimental procedures in the laboratory.
2. Understand and apply the concepts of solutions practically.
3. Apply concepts of electrochemistry in experiments.

##### II. Syllabus:

#### CST, Conductometric and Potentiometric Titrimetry

50 M

1. Determination of CST for Phenol-water system.
2. Effect of electrolyte on CST.
3. Conductometric titration - Determination of concentration of HCl solution using standard NaOH solution.
4. Conductometric titration – Determination of concentration of CH<sub>3</sub>COOH Solution using standard NaOH solution.
5. Potentiometric titration-Determination of concentration of HCl using standard NaOH solution.

##### III. Co-curricular activities and Assessment Methods;

- 1) Continuous Evaluation: Monitoring the progress of student's learning
- 2) Class Tests, Worksheets and Quizzes
- 3) Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality

- 4) SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

**IV. List of reference books:**

- 1) A Text Book of Quantitative Inorganic Analysis(3<sup>rd</sup>Edition) –A.I.Vogel
- 2) Web related references suggested by teacher.

### III -SEMESTER

#### COURSE CODE 8: INORGANIC AND PHYSICAL CHEMISTRY

Credits: 03

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#### I. Course outcomes:

At the end of the SEMESTER the student will be able to:

- 1) Apply IUPAC nomenclature for Coordination compounds
- 2) Understand the various theories, structure and stereo chemistry of coordination compounds.
- 3) Explain the reaction mechanism in complexes.
- 4) Apply the 18 electron rule.
- 5) Discuss the basic concepts of thermodynamics.

#### II. Syllabus;

##### Unit I Coordination Chemistry-I ( 9 h )

IUPAC nomenclature of Coordination compounds, structural and stereo isomerism in complexes with coordination numbers 4 and 6. Valence Bond Theory(VBT):Postulates-magnetic properties- Inner and outer orbital complexes. Limitations of VBT, CFT- Postulates - Splitting in Octahedral, tetrahedral, tetragonal and square planar fields. Crystal field stabilization energy(CFSE), Crystal field effects for weak and strong fields. Factors affecting the magnitude of crystal field splitting energy, Spectro chemical series, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion.

##### UNIT-II Coordination Chemistry II ( 9 h )

##### 1. Inorganic molecular Reaction Mechanism: ( 6 h )

Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Labile and inert complexes, ligand substitution reactions –  $SN_1$  and  $SN_2$ , Substitution reactions in square planar complexes, Trans-effect, theories of trans effect and its applications

## **2. Stability of metal complexes: ( 3 h )**

Thermodynamic stability and kinetic stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method and mole ratio method.

## **Unit III Organo metallic compounds ( 9 h )**

Definition and classification of organo metallic Compounds on the basis of bond type, Metalcarbonyls:18electron rule, electron count of mononuclear, poly nuclear and substituted metal carbonyls of 3d series. General methods of preparation of mono and binuclear carbonyls of 3d series.  $\pi$ -acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

## **Unit IV Thermodynamics- I ( 9 h )**

Concept of heat(q), work(w), internal energy(U), State function and Path function- statement of first law; enthalpy(H), relation between heat capacities, calculations of q, w, U and H for reversible, irreversible processes, Joule-Thomson effect- coefficient, Calculation of work for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes. Temperature dependence of enthalpy of formation- Kirchoff's equation.

## **Unit V Thermodynamics II ( 9 h )**

Second law of thermodynamics Different Statements of the law, Carnot cycle and its efficiency, Carnot theorem, Concept of entropy, entropy as a state function, entropy changes in reversible and irreversible processes. Entropy changes in spontaneous and equilibrium processes. Third law of thermodynamics, Nernst heat theorem, Spontaneous and non-spontaneous processes, Helmholtz and Gibbs equation - Criteria for spontaneity.

### **III. List of Reference Books:**

- 1) Concise coordination chemistry by Gopalan and Ramalingam
- 2) Coordination Chemistry by Basalo and Johnson
- 3) Text book of physical chemistry by S Glasstone



- 4) Concise Inorganic Chemistry by J.D.Lee
- 5) Advanced Inorganic Chemistry Vol-I by Satyaprakash, Tuli, Basu and Madan
- 6) A Text Book of Physical Chemistry by K.L.Kapoor Vol 2, 6<sup>th</sup> edition, 2019.

### III - SEMESTER

#### COURSE CODE 8: QUALITATIVE INORGANIC ANALYSIS

Credits: 01

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#### Qualitative inorganic analysis

( Minimum of Six mixtures should be analyzed)

#### Course outcomes:

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

- 1) Understand the basic concepts of qualitative analysis of inorganic mixture.
- 2) Use glassware, equipment and chemicals and follow experimental procedures in the laboratory.
- 3) Apply the concepts of common ion effect, solubility product and concepts related to qualitative analysis.

#### Analysis of Mixture

50M

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, Aluminium, Zinc, Nickel, Manganese, Calcium, Strontium, Barium, magnesium and Ammonium.

Minimum of Six mixtures should be analyzed.

#### Co-curricular activities and Assessment Methods

- 1) Continuous Evaluation: Monitoring the progress of student's learning
- 2) Class Tests, Worksheets and Quizzes

- 3) Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
- 4) SEMESTER - End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

**List of Text books:**

1. A textbook of qualitative inorganic analysis by A.I. Vogel.

## IV - SEMESTER

### COURSE CODE 9: PHYSICAL CHEMISTRY -II

(States of Matter, Phase Rule & Surface Chemistry)

Credits: 03

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#### I. Course outcomes:

At the end of the SEMESTER the student will be able to:

1. Explain the difference between solids liquids and gases in terms of intermolecular interactions.
2. Differentiate ideal and real gases.
3. Discuss the basic concepts of two component systems
4. Apply the concepts of adsorption.
5. Understand the basic concepts of crystallography.

#### II. Syllabus:

##### Unit I - Gaseous state (9 h )

Postulates of Kinetic theory of Gases (exclude derivation) – deduction of gas laws from kinetic gas equation-Vander Waal's equation of state. Andrew's isotherms of carbon dioxide, continuity of state. Critical phenomena. Relationship between critical constants and vander Waal's constants. Law of corresponding states. Joule- Thomson effect. Inversion temperature.

##### Unit II – Liquid State (9 h )

Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

Liquid crystals, mesomorphic state. Differences between liquid crystal and solid/liquid. Classification of liquid crystals into Smectic and Nematic. Application of liquid crystals as LCD devices

### **UNIT-III - Solid state ( 9h )**

Symmetry in crystals. Law of constancy of interfacial angles. The law of rationality of indices. Miller indices, Definition of lattice point, space lattice, unit cell. Bravais lattices and crystal systems. X-ray diffraction and crystal structure. Bragg's law and its derivation. Powder method. Defects in crystals. Stoichiometric and non-stoichiometric defects.

### **Unit IV - Phase Rule ( 9 h )**

The Concept of phase, components, degrees of freedom. Gibbs phase rule. Phase diagram of one component system – water system, Study of Phase diagrams of Simple eutectic systems

i) Pb-Ag system, desilverisation of lead ii) NaCl-Water system, Congruent and incongruent melting point- Definition and examples for systems having congruent and incongruent melting point, freezing mixtures

### **Unit V Surface Chemistry ( 9 h )**

Definition and classification of Colloids- Coagulation of colloids- Hardy-Schulze rule. Stability of colloids, Protection of Colloids, Gold number.

Adsorption - Physical and chemical adsorption, Freundlich and Langmuir adsorption isotherm, applications of adsorption.

### **III. List of Reference Books:**

- 1) Solid State Chemistry and its applications by Anthony R. West
- 2) Text book of physical chemistry by K L Kapoor Vol.1
- 3) Text book of physical chemistry by S Glasstone
- 4) Advanced physical chemistry by Bahl and Tuli.

## IV - SEMESTER

### Course Code 9: Organic Preparations

Credits: 01

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#### Course outcomes:

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

- 1) Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- 2) Apply concepts of surface chemistry in experiments.
- 3) Be familiar with the concepts & practical applications of Surface tension and viscosity of liquids.

#### Physical Chemistry Practical Syllabus:

1. Determination of surface tension of liquid by drop count method
2. Determination of surface tension of liquid by drop weight method
3. Determination of surface tension of mixture (liquid + detergent) using stalagmometer.
4. Determination of coefficient of viscosity of an organic liquid.
5. Determination of composition of a glycerol in glycerol + water mixture using viscometer.
6. Adsorption of acetic acid on animal charcoal, verification of Freundlich isotherm.

#### Co-curricular activities and Assessment Methods:

- 1) Continuous Evaluation: Monitoring the progress of student's learning
- 2) Class Tests, Worksheets and Quizzes
- 3) Presentations, Projects and Assignments and Group Discussions: Enhances

critical thinking skills and personality

- 4) SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

**List of reference books:**

- 1) A Text Book of Quantitative Inorganic Analysis(3<sup>rd</sup>Edition) –A.I.Vogel
- 2) Web related references suggested by teacher.

## IV - SEMESTER

### Course Code 10: GENERAL AND PHYSICAL CHEMISTRY

Credits: 03

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#### I. Course outcomes:

At the end of the SEMESTER the student will be able to:

1. Correlate and describe the stereochemical properties of organic compounds.
2. Explain the biological significance of various elements present in the human body.
3. Apply the concepts of ionic equilibrium for the qualitative and quantitative analysis.
4. Determine the order of a chemical reaction.
5. Describe the basic concepts of enzyme catalysis.

#### II. Syllabus:

##### UNIT-I Stereo chemistry of carbon compounds ( 9 h )

Molecular representations - Wedge, Fischer, Newman and Saw-Horse formulae.

Optical isomerism: Optical activity- wave nature of light, plane polarised light, optical rotation and specific rotation. Chiral molecules- definition and criteria (Symmetry elements)- Definition of enantiomers and diastereomers – Explanation of optical isomerism with examples- Glyceraldehyde, Lactic acid, Alanine, Tartaric acid, 2,3-dibromopentane.

##### Unit II Bioinorganic Chemistry ( 9 h )

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals, Na / K- pump, carbonic anhydrase and carboxy peptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin-transfer of oxygen, Myoglobin-Storage and transfer of iron

### **Unit III Ionic equilibrium ( 9 h )**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, Buffer solutions-Henderson's equation. Indicators-theories of acid – base Indicators, selection of Indicators,

Common ion effect Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

### **Unit IV Chemical Kinetics-I: ( 9 h )**

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, Derivation of integrated rate equations for zero, first and second order reactions (similar and different reactants). Half-life of a reaction. General methods for determination of order of a reaction.

### **Unit V Chemical Kinetics-II: ( 9 h 0**

Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Enzyme catalysis- Specificity, factors affecting enzyme catalysis, Inhibitors and Lock & key model. Michaels- Menten equation- derivation, significance of Michaelis-Menten constant.

### **III. Reference books**

- 1) Text book of physical chemistry by S Glasstone
- 2) Concise Inorganic Chemistry by J.D.Lee
- 3) Advanced physical chemistry by Gurudeep Raj
- 4) Advanced physical chemistry by Bahl and Tuli
- 5) Inorganic Chemistry by J.E.Huheey
- 6) Basic Inorganic Chemistry by Cotton and Wilkinson.



## IV - SEMESTER

### Course Code 10: Physical Chemistry - Volumetric Analysis

Credits: 01

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#### Physical Chemistry - Volumetric Analysis

#### IV. Course outcomes:

At the end of the course, the student will be able to;

1. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
2. Understand and explain the volumetric analysis based on fundamental concepts learnt in ionic equilibria
3. Learn and identify the concepts of a standard solutions, primary and secondary standards
4. Facilitate the learner to make solutions of various molar concentrations.

#### V. Syllabus:

##### Volumetric analysis:

1. Estimation of sodium hydroxide using standardised HCl solution.
2. Estimation of sodium carbonate and sodium hydroxide present in a mixture.
3. Determination of Fe (II) using  $\text{KMnO}_4$  with oxalic acid as primary standard. (internal indicator method)
4. Determination of Fe (II) using  $\text{KmnO}_4$  with oxalic acid as primary standard. (external indicator method)
5. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KmnO}_4$

#### VI. Co-curricular activities and assessment methods :

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions:  
Enhances critical thinking skills and personality

4. SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

**VII. List of reference books:**

1. A Text Book of Quantitative Inorganic Analysis(3<sup>rd</sup>Edition) –A.I.Vogel
2. Web related references suggested by teacher.

## IV - SEMESTER

### Course Code 11: Nitrogen containing Organic Compounds & Spectroscopy

Credits: 03

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#### Nitrogen containing Organic Compounds & Spectroscopy

##### I. Course outcomes:

At the end of the SEMESTER the student will be able to:

1. Distinguish primary secondary and tertiary amines and their properties.
2. Describe the preparation and properties of amino acids.
3. Explain the reactivity of nitro hydrocarbons.
4. Discuss heterocyclic compounds with N, O and S.
5. Apply the concepts of UV and IR to ascertain the functional group in an organic compound.

##### II. Syllabus:

###### Unit I Amines: ( 9 h )

Classification, chirality in amines (pyramidal inversion), preparations – Gabriel synthesis,

Hoffmann- Bromamide reaction ( with mechanism), reduction of amides and Schmidt reaction. Distinction between Primary, secondary and tertiary amines using Hinsberg's method and nitrous acid. Discussion of the following reactions with emphasis on the mechanistic pathway: Carbylamine reaction, Hoffmann's exhaustive methylation, Hofmann and Cope elimination.

Diazonium Salts: Preparation and synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, cyano and nitro compounds. Coupling reactions of diazonium salts (preparation of azo dyes).

###### UNIT- II Amino acids ( 9 h )

Definition and classification of Amino acids into alpha, beta, and gamma amino acids. Natural and essential amino acids - definition and examples, classification of alpha amino acids into acidic, basic and neutral amino acids with examples. Methods of synthesis: a) from halogenated carboxylic acid, b) Gabriel Phthalimide synthesis c) Strecker's synthesis.

Physical properties: Zwitter ion structure - salt like character - solubility, melting points, amphoteric character, definition of isoelectric point. Chemical properties: General reactions due to amino and carboxyl groups - lactams from gamma and delta amino acids by heating-peptide bond (amide linkage). Structure and nomenclature of peptides and proteins.

### **UNIT- III Nitro hydrocarbons ( 9h )**

Nomenclature and classification, structure -Tautomerism of nitroalkanes leading to acid and keto form, Preparation of Nitroalkanes, reactivity - halogenation, reaction with HONO (Nitrous acid), Nef reaction and Mannich reaction leading to Micheal addition and reduction.

### **Unit IV Heterocyclic Compounds ( 9 h )**

Introduction and definition: Simple five membered ring compounds with one hetero atom Ex. Furan, Thiophene and Pyrrole - Aromatic character – Preparation from 1, 4, -dicarbonyl compounds, Paul-Knorr synthesis. Properties: Acidic character of pyrrole - electrophillic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation - Diels Alder reaction in furan. Pyridine – synthesis - Aromaticity -Basicity - Comparison with pyrrole- one method of preparation and properties - Reactivity towards Nucleophilic substitution reaction.

### **Unit V UV-Visible & IR Spectroscopy ( 9 h )**

Selection rules for electronic spectra, types of electronic transitions in molecules, concept of chromophore and auxochrome, effect of conjugation- Woodward Fischer rules for calculating  $\lambda_{\max}$  of conjugated dienes and  $\alpha,\beta$  unsaturated compounds. Infrared spectroscopy and types of molecular vibrations and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intra molecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on  $>C=O$  stretching absorptions).

### **III. List of Reference Books**

- 1) A Text Book of Organic Chemistry by Bahl and Arunbahl
- 2) A Text Book of Organic chemistry by I L Finar Vol I
- 3) Organic chemistry by Bruice
- 4) Organic chemistry by Clayden

- 5) Spectroscopy by William Kemp
- 6) Spectroscopy by Pavia
- 7) Organic Spectroscopy by J. R. Dyer
- 8) Elementary organic spectroscopy by Y.R. Sharma
- 9) Spectroscopy by P.S.Kalsi
- 10) Spectrometric Identification of Organic Compounds by Robert M Silverstein, Francis X Webster

#### **IV - SEMESTER**

#### **Course Code 11: Organic preparations and IR Spectral Analysis**

**Credits: 01**

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#### **Organic preparations and IR Spectral Analysis**

##### **Course outcomes:**

On completion of the course, the student will be able to:

- 11) Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- 12) Calculate limiting reagent, theoretical yield, and percent yield
- 13) Engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
- 14) Dispose of chemicals in a safe and responsible manner
- 15) Perform common laboratory techniques including reflux, distillation, recrystallization, vacuum filtration.
- 16) Create and carry out work up and separation procedures.

##### **Syllabus:**

##### **A. Organic preparations: 40M**

- 1) Acetylation of one of the following compounds: amines (aniline, o-, m-, ptoluidines and o-, m-, p-anisidine)

- a. Using conventional method.
  - b. Using green approach
- 2) Benzoylation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine)
  - 3) Nitration of any one of the following:  
Acetanilide/nitrobenzene by conventional method

### **B. IR Spectral Analysis 10M**

IR Spectral Analysis of the following functional groups with examples a) Hydroxyl groups b) Carbonyl groups c) Amino groups d) Aromatic groups

### **Co-curricular activities and assessment methods:**

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions:  
Enhances critical thinking skills and personality
4. SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

### **List of reference books:**

1. Vogel A.I. Practical Organic Chemistry, Longman Group Ltd.
2. Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
3. Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.
4. Web related references suggested by teacher.

## V- SEMESTER

### Course Code 12 A: ANALYTICAL METHODS IN CHEMISTRY-

#### QUANTITATIVE ANALYSIS

Credits: 03

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#### ANALYTICAL METHODS IN CHEMISTRY- QUANTITATIVE ANALYSIS

#### SKILL ENHANCEMENT COURSE (ELECTIVE)

##### I. Learning Outcomes:

Students after successful completion of the course will be able to:

- 1) Identify the importance of solvent extraction and ion exchange method.
- 2) Acquire knowledge on the basic principles of volumetric analysis and gravimetric analysis.
- 3) Demonstrate the usage of common laboratory apparatus used in quantitative analysis.
- 4) Understand the theories of different types of titrations.
- 5) Gain knowledge on different types of errors and the minimization methods.

##### II. Syllabus:

#### Unit-1: Quantitative analysis-1 (9 hours)

A brief introduction to analytical methods in chemistry. Principles of volumetric analysis, concentration terms- Molarity, Molality, Normality, v/v, w/v, ppm and ppb, preparing solutions- Standard solution, primary standards and secondary standards.. Description and use of common laboratory apparatus- volumetric flask, burette, pipette, beakers, measuring cylinders.

#### Unit-2: Quantitative analysis-2 (9 hours)

Principles of volumetric analysis: Theories of acid-base (including study of acid-base titration curves), redox, complex metric, iodometric and precipitation titrations-choice of indicators for the saturations. Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration, and washing of precipitate, drying and ignition.

### **Unit-3: Treatment of analytical data (9 hours)**

Types of errors- Relative and absolute, significant figures and its importance, accuracy - methods of expressing accuracy, errors- Determinate and indeterminate and minimization of errors, precision-methods of expressing precision, standard deviation and confidence interval.

### **Unit-4: Separation techniques (9hours)**

Solvent Extraction: Introduction, principle, techniques, factors affecting solvent extraction, Batch extraction, Continuous extraction and counter current extraction. Synergism.

Application-Determination of Iron(III). Ion Exchange method: Introduction, action of ion exchange resins, applications.

### **UNIT-5: Analysis of water ( 9 hours)**

Determination of dissolved solids, total hardness of water, turbidity, alkalinity, Dissolved oxygen, COD, determination of chloride using Mohr's method.

#### **III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.

#### **IV. List of Reference Books:**

- 1) Fundamentals of Analytical Chemistry by F.James Holler, Stanley R Crouch, DonaldM.West and Douglas A. Skoog, Ninth edition, Cengage.
- 2) Analytical Chemistry by Gary D.Christian, Purnendu K.Dasgupta and KevinA. Schug, Seventh edition, Wiley.
- 3) Quantitative analysis by R.A.DayJr.and A.L.Underwood, Sixth edition, Pearson.
- 4) Text book of Vogel's Quantitative Chemical Analysis,Sixth edition, Pearson.
- 5) Text book of Environmental Chemistry and Pollution Control by S.S.Dara and D.D.Mishra, Revised edition, S Chand & Co Ltd.



## V- SEMESTER

**Course Code 12 A: Analytical Methods in Chemistry – Quantitative analysis:**

**Credits: 01**

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### **Analytical Methods in Chemistry – Quantitative analysis:**

#### **V. Learning Outcomes:**

On successful completion of this practical course, student shall be able to:

- 1) Estimate Iron(II) using standard Potassium dichromate solution
- 2) Learn the procedure for the estimation of total hardness of water
- 3) Demonstrate the determination of chloride using Mohr's method
- 4) Acquire skills in the operation and calibration of pH meter
- 5) Perform the strong acid vs strong base titration using pH meter

#### **VI. Laboratory course Syllabus:**

- 1) Estimation of Iron(II) using standard Potassium dichromate solution (using DPA indicator)
- 2) Estimation of total hardness of water using EDTA
- 3) Determination of chloride ion by Mohr's method
- 4) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- 5) Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid, (ii) Ammonium chloride-ammonium hydroxide.
- 6) pH metric titration of (i) strong acid vs strong base, (ii) weak acid vs. Strong base.
- 7) Determination of dissociation constant of a weak acid.

#### **VII. Co-Curricular Activities:**

Mandatory: *(Lab /field training of students by teacher: (lab:10+field:05):*

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques / skills of calibration of pH meter, Strong acid vs strong base titration using pH meter, determination of chloride ion, estimation of water quality parameters and estimation of Iron(II).
- 2) **For Student:** Student shall visit a related industry / chemistry laboratory in universities / research organizations/private sector facility and observe various methods used for the analysis of water. Write their observations and submit a hand written fieldwork /project work report not exceeding 10 pages in the given format to the teacher.
- 3) **Max marks for Field work / projectwork Report:05.**
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

#### **VIII. List of Reference books:**

Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

## V- SEMESTER

### Course 12 B : Environmental Chemistry

Credits: 03

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#### Learning Outcomes:

Students after successful completion of the course will be able to:

- 1) Understand the environment functions and how it is affected by human activities.
- 2) Acquire chemical knowledge to ensure sustainable use of the world's resources and ecosystems services.
- 3) Engage in simple and advanced analytical tools used to measure the different types of pollution.
- 4) Explain the energy crisis and different aspects of sustainability.
- 5) Analyze key ethical challenges concerning biodiversity and understand the moral principles, goals and virtues important for guiding decisions that affect Earth's plant and animal life.

#### II Syllabus

##### UNIT-I Environmental chemistry 9h

Definition – Concept of Environmental chemistry-Scope and importance of environment in now a days – Nomenclature of environmental chemistry – Segments of environment-Effects of human activities on environment – Natural resources-Renewable Resources-Solar and Biomass Energy and Nonrenewable resources – Thermal power and atomic energy – Reactions of atmospheric oxygen and Hydrological cycle.

##### UNIT-II Air Pollution 9h

Definition – Sources of air pollution – Classification of air pollution – Ambient air quality standards- Climate change – Global warming – Pollution from combustion systems- Acid rain –Photochemical smog – Green house effect – Formation and depletion of ozone –

Bhopal gas disaster–Instrumental techniques to monitor pollution – Controlling methods of air pollution.

### **UNIT-III**

#### **Water pollution      9h**

Unique physical and chemical properties of water – Water quality standards and parameters – Turbidity- pH Dissolved oxygen – BOD, COD, Suspended solids, total dissolved solids, alkalinity–Hardness of water–Methods to convert temporary hard water into soft water – Methods to convert permanent hard water into soft water – eutrophication and its effects –Industrial waste water treatment.

### **UNIT-IV**

#### **Chemical Toxicology      9h**

Toxic chemicals in the environment – effects of toxic chemicals – cyanide and its toxic effects – pesticides and its biochemical effects – toxicity of lead, mercury, arsenic and cadmium- Solid waste management.

### **UNIT-V**

#### **Ecosystem and biodiversity      9h**

**Ecosystem :** Concepts–structure–Functions and types of ecosystem– Abiotic and biotic components – Energy flow and Energy dynamics of ecosystem– Food chains – Food web– Tropic levels– Biogeochemical cycles (carbon, nitrogen and phosphorus)

#### **Bio diversity:**

Definition – level and types of biodiversity – concept- significance – magnitude and distribution of biodiversity–trends-biogeographical classification of india – biodiversity at national, global and regional level.

#### **Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, Group discussions, Debates and Quiz (on related topics).
- 3) Visits to laboratories, firms, research organizations etc.

- 4) Invited lectures and presentations on related topics by field/industrial experts.
- 5) Preparation of videos on tools, techniques on selected topics.

**I. List of Reference books:**

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
4. Water pollution, Lalude, MC Graw Hill
5. Environmental Chemistry, Anil Kumar De, Wiley Eastern ltd.
6. Environmental analysis, SM Khopkar ( IIT Bombay )
7. Environmental Chemistry by BK Sharma & H Kaur, Goel publishing house.
8. Fundamentals of Environmental Chemistry, Manahan, Stanley. E
9. Applications of Environmental Chemistry, Eugene R. Wiener
10. Web related references suggested by teacher.

**V - SEMESTER**

**Course 12 B Environmental Chemistry**

**Credits: 01**

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**Environmental Chemistry**

**Learning Outcomes:**

On successful completion of this practical course, student shall be able to:

1. List out, Identify and handle various equipment in Chemistry lab.
2. Learn the procedures of preparation of standard solutions.
3. Demonstrate skills in operating instruments.
4. Acquire skills in handling spectrophotometer.
5. Analyze water and soil samples.

**Laboratory course Syllabus:**

1. Identification of various equipment in the laboratory.

2. Determination of carbonate and bicarbonate in water samples by double titration method.
3. Determination of hardness of water using EDTA
  - a) Permanent hardness
  - b) Temporary hardness
4. Determination of Chlorides in water samples by Mohr's method.
5. Determination of pH, turbidity and total solids in water sample.
6. Determination of  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  in soil sample by flame photometry.
7. Determination of pH in soil samples using pHmetry.

### **Suggested Co-Curricular Activities:**

Mandatory:(*Lab /field training of students by teacher:(lab:10+field:05):*

- 1) For Teacher: Skills training of students by the teacher in classroom, lab and field for not less than 15 hours on field related quantitative techniques for the water quality parameters, soil pollution and air pollution.
- 2) For Student: Individual visit to any one of the local field agencies/research laboratories in universities/research organizations/private sector culminating writing and submission of a handwritten fieldwork/project work Report not exceeding 10 pages in the given format.
- 3) Max marks for Field work / project work Report:05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

### **II. List of Reference books:**

1. A Text Book of Quantitative Inorganic Analysis(3<sup>rd</sup>Edition) –A.I.Vogel
2. Water pollution, Lalude, MC Graw Hill
3. Environmental analysis, SM Khopkar ( IIT Bombay )
4. Web related references suggested by teacher.

## V - SEMESTER

### Course 13A :Chromatography and Instrumental methods of Analysis

Credits: 03

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#### Learning Outcomes:

- 1) Students after successful completion of the course will be able to:
- 2) Identify the importance of chromatography in the separation and identification of compounds in a mixture
- 3) Acquire a critical knowledge on various chromatographic techniques.
- 4) Demonstrate skills related to analysis of water using different techniques.
- 5) Understand the principles of spectrochemistry in the determination of metal ions.
- 6) Comprehend the applications of atomic spectroscopy.

#### Syllabus:

#### Unit-1: Chromatography-Introduction and classification (9 hours)

Principle, Classification of chromatographic methods, Nature of adsorbents, eluents, R<sub>f</sub> values, factors affecting R<sub>f</sub> values.

#### UNIT-2: TLC and paper chromatography (9hours)

Thin layer chromatography: Principle, Experimental procedure, preparation of plates, adsorbents and solvents, development of chromatogram, detection of spots, applications and advantages.

Paper Chromatography: Principle, Experimental procedure, choice of paper and solvents, various modes of development- ascending, descending, radial and two dimensional, applications.

#### UNIT-3: Column chromatography (9 hours)

Column chromatography: Principle, classification, Experimental procedure, stationary and mobile phases, development of the Chromatogram, applications.

HPLC: Basic principles, instrumentation–block diagram and applications.

#### **UNIT-4: Spectrophotometry ( 9 hours )**

Principle, Instrumentation : Single beam and double beam spectrometer, Beer-Lambert's law- Derivation and deviations from Beer-Lambert's law, applications of Beer-Lambert's law- Quantitative determination of  $\text{Fe}^{+2}$ ,  $\text{Mn}^{+2}$  and  $\text{Pb}^{+2}$ .

#### **UNIT-5: Polarimetry and Refractometry ( 9 hours )**

Polarimetry and Refractometry: Polarimetry: Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity. Refractometry; The refractive index, Refractometer.

#### **Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts

#### **List of Reference books:**

- 1) Fundamental so Analytical Chemistry by F.James Holler, Stanley R Crouch, Donald M.West and Douglas A.Skoog, Ninth edition, Cengage.
- 2) Analytical Chemistry by Gary D.Christian, Purnendu K.Dasgupta and Kevin A.Schug, Seventh edition, Wiley.
- 3) Quantitative analysis by R.A.Day Jr .and A.L.Underwood, Sixth edition, Pearson.
- 4) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition/Pearson.
- 5) Instrumental methods of Chemical Analysis by Dr.B.K.Sharma 1981



## V - SEMESTER

### Course 13 A: Chromatography and Instrumental methods of Analysis

Credits: 01

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#### Learning Outcomes:

On successful completion of this practical course, student shall be able to:

- 1) Perform the separation of a given dye mixture using TLC
- 2) Learn the preparation of TLC plates
- 3) Demonstrate the separation of mixture of amino acids using paper chromatography
- 4) Acquire skills in using column chromatography for the separation of dye mixture.

#### Laboratory course Syllabus:

- 1) Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
- 2) Separation of mixture of methyl orange and methylene blue by column chromatography.
- 3) Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
- 4) Separation of food dyes using Column Chromatography
- 5) Separation of triglycerides using TLC
- 6) Verification of Beer Lambert's law. (Using potassium permanganate solution) using colorimeter / spectrophotometer.

#### Co-Curricular Activities:

Mandatory: (*Lab /field training of students by teacher:(lab:10+field:05):*)

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of determination of hardness of water, using the calorimeter and or Spectrophotometer, preparation of TLC plate, identification of spots in TLC and Paper chromatographic techniques, loading of column, selection of solvent system, separation of amino acids and dyes mixture using chromatographic techniques.
- 2) **For Student:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the chromatographic techniques used for the separation of compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork/project work Report: 05 **Max marks for Field work / project work Report: 05.**
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

**List of Reference books:**

- 1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
- 2) Vogel A.I. Practical Organic Chemistry, Longman Group Ltd.
- 3) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 4) Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.
- 5) Mann F.G. and Saunders B.C, Practical Organic Chemistry, Pearson Education.

## V - SEMESTER

### Course 13 B Green Chemistry and Nanotechnology.

Credits: 03

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#### I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the importance of Green chemistry and Green synthesis.
2. Engage in Microwave assisted organic synthesis.
3. Demonstrate skills using the alternative green solvents in synthesis.
4. Demonstrate and explain enzymatic catalysis .
5. Analyse alternative sources of energy and carry out green synthesis.
6. Carry out the chemical method of nanomaterial synthesis.

#### II. Syllabus

##### UNIT-I Green Chemistry: I

9hrs

Introduction-Definition of green Chemistry,Need for green chemistry, Goals of Green chemistry Basic principles of green chemistry. Green synthesis- Evaluation of the type of the reaction i) Rearrangements (100% atom economic),ii)Addition reaction(100% atom economic). Organic reactions by Sonication method: apparatus required and examples of sono chemical reactions (Heck, Hundsdiecker and Wittig reactions).

##### UNIT- II Green Chemistry : Part- II

9hrs

###### A) Selection of solvent:

- i) Aqueous phase reactions
- ii) Reactions in ionic liquids, Heck reaction, Suzuki reactions,epoxidation.
- iii)Solid supported synthesis

**B) Supercritical CO<sub>2</sub>:**Preparation, properties and applications,(decaffeination, drycleaning)

C) Green energy and sustainability.

**UNIT-III Microwave and Ultrasound assisted green synthesis: 9hrs**

Apparatus required, examples of MAOS (synthesis of fused anthroquinones, Leukart reductive amination of ketones)-Advantages and disadvantages of MAOS. Aldol condensation –Cannizzaro reaction - Diels-Alder reactions- Strecker's synthesis

**UNIT-IV Green catalysis and Green synthesis 9hrs**

Heterogeneous catalysis, use of zeolites, silica, alumina, supported catalysis-biocatalysis: Enzymes, microbes Phase transfer catalysis (micellar/surfactant)

- 1.Green synthesis of the following compounds : adipic acid, catechol, disodium imino diacetate (alternative Strecker's synthesis)
2. Microwave assisted reaction in water –Hoffmann elimination – methyl benzoate to benzoic acid – oxidation of toluene and alcohols–microwave assisted reactions in organic solvents. Diels-Alder reactions and decarboxylation reaction.
3. Ultrasound assisted reactions–sonochemical Simmons–Smith reaction(ultrasonic alternative to iodine)

**UNIT – V Nanotechnology in Green chemistry 9hrs**

Basic concepts of Nanoscience and Nanotechnology – Bottom-up approach and Top down approaches with examples – Synthesis of Nano materials – Classification of Nanomaterials – Properties and Application of Nanomaterials. Chemical and Physical properties of Nanoparticles – Physical synthesis of nanoparticles – Inert gas condensation - aerosol method - Chemical Synthesis of nanoparticles – precipitation and co-precipitation method, sol-gel method.

**III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, Group discussions, Debates and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.

- 4) Invited lectures and presentations on related topics by field/industrial experts.
- 5) Preparation of videos on tools, techniques and applications of Green chemistry and Nanosynthesis.

#### **IV. List of Reference books:**

1. Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner
2. Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
3. Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
4. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
5. Principles and practice of heterogeneous catalysis, Thomas J.M.,Thomas M.J., John Wiley
6. Green Chemistry: Environmental friendly alternatives R S Sanghli and M.M Srivastava, Narosa Publications
7. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press (2008).
8. Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials, Vladimir A. Basiuk, Elena V. Basiuk Springer (2015)
9. Web related references suggested by teacher.

## V- SEMESTER

### Course 13 B Green Chemistry and Nanotechnology

Credits: 01

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#### V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1. List out, identify and handle various equipment in the laboratory.
2. Learn the procedures of green synthesis.
3. Demonstrate skills in the preparation of Nanomaterials.
4. Acquire skills in Microwave assisted organic synthesis.
5. Perform some applications of Nanomaterials.

#### VI. Laboratory course Syllabus:

1. Identification of various equipment in the laboratory.
2. Acetylation of 1<sup>0</sup> amine by green method: Preparation of acetanilide
3. Rearrangement reaction in green conditions: Benzil - Benzilic acid rearrangement
4. Radical coupling reaction: Preparation of 1,1-bis -2-naphthol
5. Green oxidation reaction: Synthesis of adipic acid
6. Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil
7. Preparation and characterization of Nanoparticles of gold using tea leaves.
8. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
9. Photoreduction of Benzophenone to Benzopinacol in the presence of sunlight.

#### VII. Suggested Co-Curricular Activities:

Mandatory:(*Lab /field training of students by teacher:(lab:10+field:05):*

- 1) **For Teacher:** Training of students by the teacher in the classroom or in the laboratory for not less than 15 hours on field related quantitative techniques for Enzymatic catalysis, Microwave assisted organic synthesis, Biodiesel preparation etc

2) **For Student:** Student shall visit a related industry / chemistry laboratory in universities / research organizations/private sector facility and observe various methods used for the analysis of water. Write their observations and submit a handwritten fieldwork /project work report not exceeding 10 pages in the given format to the teacher.

3) **Max marks for Field work / project work Report:05.**

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5) Unit tests (IE).

#### **VIII. List of Reference books:**

- 1) Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner
- 2) Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
- 3) Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
- 4) Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
- 5) Web related references suggested by teacher.

## V - SEMESTER

### Course 14A: Synthetic Organic Chemistry.

Credits: 03

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#### I. Learning Outcomes:

Students after successful completion of the course will be able to:

- 1) Identify the importance of reagents used in the synthesis of organic compounds.
- 2) Acquire knowledge on basic concepts in different types of pericyclic reactions.
- 3) Understand the importance of retro synthesis inorganic chemistry.
- 4) Comprehend the applications of different reactions in synthetic organic chemistry.

#### II. Syllabus:

##### Unit-1: Pericyclic reactions 9 hours

Definition and classification of pericyclic reactions: Phases, nodes and symmetry properties of molecular orbital's in ethylene, 1,3-butadiene, 1,3,5-hexatriene, alkylation and allyl radical. Thermal and photochemical reactions. Electro cyclic reactions: Definition and examples, definitions of con and disrotation, Woodward-Hoffmann selection rules. (Correlation diagrams excluded) Cyclo addition reactions: Definition and examples, definitions of supra facial and antar facial addition, Woodward- Hoffmann selection rules. (Correlation diagrams excluded)

##### Unit-2 : Organic photochemistry 9hours

Jablonski diagram-singlet and triplet States Photochemistry of Carbonyl compounds  $n-\pi^*$  and  $\pi-\pi^*$  transitions, Norrish type-1 and type-2 reactions Paterno-Buchi reaction.

##### Unit-3 : Retrosynthesis 9 hours

Important terms in Retro synthesis with examples-Disconnection, Target molecule, FGI, Synthons, Retrosynthetic analysis, chemo selectivity, region selectivity. Importance of Order of events in organic synthesis. Retrosynthetic analysis of the compounds: a) cyclohexene b) 4-Nitro toluene c) Paracetamol.



#### **Unit-4 : Synthetic Reactions            9 hours**

Shapiro reaction, Stork - enamine reaction(only alkylation), Wittig reaction, Robinson annulation, Bailys-Hillman reaction, Heck reaction, Suzuki coupling. Synthesis of aldehydes and ketones using 1, 3-Dithiane.

#### **Unit-5 : Reagents in Organic Chemistry    9 hours**

Oxidizing agents: PCC, PDC, SeO<sub>2</sub> (Riley oxidation), NBS.

Reducing agents : LiAlH<sub>4</sub>(with mechanism), LTBA, Metal-solvent reduction (Birch reduction), Catalytic reduction.

#### **III.    Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

#### **IV.    List of Reference books:**

- 1) Pericyclic reactions by Ian Fleming, Second edition, Oxford University press.
- 2) Pericyclic Reactions- A Text book: Reactions, Applications and Theory by S.Sankararaman, WILEY-VCH.
- 3) Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P.Singh, Revised edition, Trinity Press.
- 4) Pericyclic reactions – A Mechanistic study by S.M.Mukherji, Macmillan India.
- 5) Organic synthesis :The disconnection approach by Stuart Warren, John Wiley&Sons.
- 6) Organic chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren, Second edition, Oxford university press.
- 7) Reactions, Reagents and Rearrangements by S.N. Sanyal, Bharati Bhawan Publishers &Distributors

## V - SEMESTER

### Course - 14-A Synthetic Organic Chemistry

Credits: 01

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#### V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

- 1) Perform the organic qualitative analysis for the detection of N, S and halogens using the green procedure.
- 2) Learn the procedure for the separation of mixture of amino acids using paper Chromatography.
- 3) Prepare the TLC plates for TLC chromatography.
- 4) Acquire skills in conducting column chromatography for the separation of dyes in the given mixture.

#### VI. Laboratory course syllabus:

- 1) Green procedure for organic qualitative analysis: Detection of N,S and halogens
- 2) Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
- 3) Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
- 4) Separation of mixture of methyl orange and methylene blue by column chromatography
- 5) Separation of food dyes using Column Chromatography
- 6) Separation of triglycerides using TLC

#### VII. Suggested Co-Curricular Activities

- 1) Mandatory: *(Lab/field training of students by teacher: (lab:10+field:05):*
- 2) For Teacher: Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of detection of N, S and halogens using the green procedure, preparation of TLC plates, detection of organic compounds using R<sub>f</sub> values in TLC / paper chromatography, loading of column, selection of solvent

system for column chromatography, separation of amino acids and dye mixture using chromatographic techniques.

- 3) For Students : Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 4) Max marks for Fieldwork/project work Report: 05.
- 5) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- 6) Unit tests (IE).

#### **VIII. List of Reference books :**

- 1) Vogel A.I. Practical Organic Chemistry, Longman Group Ltd.
- 2) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 3) Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press.
- 4) Mann F.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

## V - SEMESTER

### - Course 14 B:Industrial Chemistry- Fertilisers and Surface coatings

Credits: 03

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#### I. Learning Outcomes:

Students after successful completion of the course will be able to:

- 1) Identify the importance of different surface coatings.
- 2) Acquire a critical knowledge on manufacture of ceramics and cement.
- 3) Understand various steps in the manufacture of cane sugar.
- 4) Explain the manufacture of pulp and paper.

#### II. Syllabus:

##### Unit-1: Fertilizers 9 hours

A brief introduction to industrial chemistry. Different types of fertilizers. Manufacture of the following fertilizers :Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphates; Polyphosphate, Superphosphate, Compound and mixed fertilizers.

##### Unit-2: Silicates 9 hours

Ceramics: Important clays and Feldspar. Ceramics - types, uses and manufacture. High technology ceramics and their applications.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

##### Unit-3 : Surface Coatings 9 hours

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments - formulation, composition and related properties. Oil paint ,modified oils, Pigments, toners and lake pigments, fillers, thinners, enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Water and Oil paints.

#### **Unit-4: Sugar Chemistry    9hours**

Introduction – Manufacture and recovery of cane sugar from molasses, manufacture of sucrose from beet root, testing and estimation of sucrose.

#### **Unit-5: Paper Industry        9 hours**

Pulp and Paper-Introduction, Manufacture of pulp, sulphate or Kraft pulp, soda pulp, sulphite pulp, rag pulp, beating, refining, filling, sizing and colouring of pulp, manufacture of paper.

#### **III.    Suggested Co – Curricular Activities:**

- 1)    Training of students by related industrial experts.
- 2)    Assignments, Seminars, debates , discussions and Quiz(on related topics).
- 3)    Visits to industries, firms, research organizations etc.
- 4)    Invited lectures and presentations on related topics by field/industrial experts.
- 5)    Preparation of PPTS and videos.

#### **IV.    List of Reference books:**

- 1) J.A.Kent : Riegel's Hand book of Industrial Chemistry, CBS Publishers, New Delhi.
- 2) P.C.Jain, M.Jain : Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- 3) R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- 4) B.K.Sharma: Engineering Chemistry,Goel Publishing House,Meerut
- 5) O. P. Vermani, A. K. Narula: Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.

## V - SEMESTER

### Course - 14-B Industrial Chemistry- Fertilizers and Surface coatings

Credits: 01

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#### V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

- 1) Determine free acidity in ammonium sulphate fertilizer.
- 2) Learn the procedure for the Estimation of Calcium in Calcium ammonium nitrate fertilizer.
- 3) Demonstrate skills on Estimation of phosphoric acid in superphosphate fertilizer.
- 4) Acquire skills in using colorimeter for the estimation of sucrose.

#### VI. Laboratory course Syllabus:

- 1) Determination of free acidity in ammonium sulphate fertilizer.
- 2) Estimation of Calcium in Calcium ammonium nitrate fertilizer.
- 3) Estimation of phosphoric acid in superphosphate fertilizer.
- 4) Estimation of sucrose by colorimetry.

#### VII. Suggested Co-Curricular Activities:

Mandatory: *(Lab / field training of students by teacher : (lab:10+field:05):*

- 1) For Teacher: Training of students by the teacher in laboratory and field for not less than 15 hours on field related skills in determination of free acidity, estimation of calcium and phosphoric acid in a fertilizer, use of colorimeter to estimate sucrose.

- 2) For Student :Student shall visit a related industry /chemistry laboratory in universities/research organizations/private sector facility and observe the surface coatings of surfaces used to prevent the corrosion. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Field work/ project work Report:05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests(IE).

**VIII. List of Reference books:**

- 1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
- 2) Text book on Experiments and Calculations in Engineering Chemistry, S.S.Dara, S.Chand.
- 3) R.Gopalan, D.Venkappayya, S.Nagarajan: Engineering Chemistry, Vikas Publications.
- 4) B.K.Sharma: Engineering Chemistry, Goel Publishing House, Meerut

## V - SEMESTER

### Course 15 A Analysis of Organic Compounds

Credits: 03

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#### I. Learning Outcomes:

Students after successful completion of the course will be able to:

- 1) Identify the importance of mass spectrometry in the structural elucidation of organic compounds.
- 2) Acquire the knowledge on structural elucidation of organic compounds.
- 3) Understand various chromatography methods in the separation and identification of organic compounds.
- 4) Demonstrate the knowledge gained in solvent extraction for the separate the organic compounds.

#### II. Syllabus:

##### Unit-I: Nuclear Magnetic Resonance (NMR) spectroscopy 9 h

Principles of nuclear magnetic resonance, equivalent and non-equivalent protons, position of signals. Chemical shift, NMR splitting of signals - spin-spin coupling, coupling constants. Applications of NMR with suitable examples - ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromo ethane, ethyl acetate, toluene and acetophenone.

##### Unit II Mass Spectrometry 9hrs

A brief introduction to analysis of organic compounds

Basic principles, Instrumentation - Mass spectrometer, electron Ionization (Electron Impact ionization, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, Butaldehyde, Propionic acid.

##### Unit-III : Structural elucidation of organic compounds using IR, NMR & mass spectral data- 9 hours



2,2,3,3-Tetramethyl butane, Butane-2,3-dione, Propionic acid and methyl propionate.  
Phenyl acetylene, acetophenone, cinnamic acid and p-nitroaniline.

#### **Unit-IV: Separation techniques-1 9 hours**

Solvent extraction-Principle and theory, Batch extraction technique, application of batch extraction in the separation of organic compounds from mixture- acid & neutral, base & neutral.

Chromatography – Principle and theory, classification, types of adsorbents, eluents, R<sub>f</sub> values and factors affecting R<sub>f</sub> values. Thin layer chromatography - principle, experimental procedure, advantages and applications.

#### **Unit-5: Separation techniques - 2 9 hours**

Paper chromatography- Principle, experimental procedure, ascending, descending, radial and two dimensional, applications.

Column chromatography - Principle, classification, experimental procedure and applications.

HPLC-Principle, Instrumentation – block diagram and applications.

### **III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

### **IV. List of Reference books:**

- 1) Organic Spectroscopy by William Kemp, Third Edition, Palgrave USA.
- 2) Introduction to Spectroscopy by Pavia, Lampman, Kriz and Vyvyan, Fifth edition, Cengage.
- 3) Organic Spectroscopy: Principles and Applications by Jag Mohan, Second edition, Alpha Science.
- 4) Spectroscopy of Organic Compounds by P.S.Kalsi, Seventh edition, New Age

International.

- 5) Spectroscopic Methods in Organic Chemistry by Ian Fleming and Dudley Williams, Seventh edition, Springer.
- 6) Fundamentals of Analytical Chemistry by F.James Holler, Stanley R Crouch, Donald M.West and Douglas A.Skoog, Ninth edition, Cengage.
- 7) Analytical Chemistry by Gary D.Christian, Purnendu K.Dasgupta and KevinA.Schug, Seventh edition, Wiley.
- 8) Quantitative analysis by R.A.DayJr.andA.L.Underwood, Sixth edition, Pearson.
- 9) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

## V - SEMESTER

### Course – 15 A Analysis of Organic Compounds

Credits: 01

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#### V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

- 1) Prepare acetanilide using the green synthesis.
- 2) Demonstrate the preparation of an azo dye.
- 3) Acquire skills in the separation of organic compounds in the given mixture using solvent extraction

#### VI. Laboratory course Syllabus:

- 1) Identification of various equipment in the laboratory.
- 2) Acetylating of 1<sup>o</sup>amine by green method : Preparation of acetanilide
- 3) Rearrangement reaction in green conditions : Benzil-Benzilic acid rearrangement
- 4) Radical coupling reaction : Preparation of 1,1-bis-2-naphthol
- 5) Green oxidation reaction: Synthesis of adipic acid
- 6) Preparation and characterization of biodiesel from vegetable oil/waste cooking oil.
- 7) Photo reduction of Benzophenone to Benzopinacol in the presence of sunlight.
- 8) Separation of organic compounds in a mixture(acidic compound + neutral compound) using solvent extraction.
- 9) Separation of organic compounds in a mixture (basic compound+ neutral compound) using solvent extraction.

#### VII. Suggested Co-Curricular Activities:

Mandatory: (*Lab / field training of students by teacher:(lab:10+field:05):*)

- 1) For Teacher: Training of students by teacher in laboratory and field for not less than 15 hours on the field techniques/skills of preparation of acetanilide, preparation of azo dye, use of separating funnel for solvent extraction, separation of organic compounds in a mixture.
- 2) For Student : Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the techniques used for the separation of organic compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork / project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- 5) Unit tests (IE).

#### **VIII. List of Reference books :**

- 1) Vogel A.I. Practical Organic Chemistry, Longman Group Ltd.
- 2) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 3) Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press.
- 4) Mann F.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

**Course 15 B : Industrial Chemistry- Polymers and water analysis**

**Credits: 03**

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**I. Learning Outcomes:**

Students after successful completion of the course will be able to:

- 1) Understand the basic concepts of polymers
- 2) Acquire a critical knowledge on the preparation and applications of organic polymers.
- 3) Explain the sources of air pollution.
- 4) Demonstrate the analysis of water quality parameters.
- 5) Identify the importance of industrial waste management.

**II. Syllabus:**

**Unit-1: Organic Polymers-1            9 hours**

Basic definitions, degree of polymerization, classification of polymers-Natural and Synthetic polymers, Organic and Inorganic polymers, Thermo plastic and Thermosetting polymers, Plastics, Elastomers, Fibers and Resins, Linear, Branched and Cross-Linked polymers.

**Unit-2: Organic Polymers-2            9 hours**

Addition polymers and Condensation polymers, mechanism of polymerization- Free radical, ionic and Zeigler-Natta polymerization. Industrial manufacturing and applications of following polymers, Polystyrene, Poly acrylo nitrile, Poly methacrylate, Polymethyl- methacrylate.

**Unit-3: Air Pollution                    9 hours**

Sources of air pollution, acid rain, photochemical smog, Greenhouse effect, Formation and depletion of ozone, sources and effects of various gaseous pollutants: NO<sub>x</sub>, SO<sub>x</sub>, SPM, CO, hydrocarbons, controlling methods of air pollution.

**Unit-4 Analysis of water    9hours**

Determination of total hardness of water, Dissolved oxygen, BOD, COD, total dissolved solids, turbidity, alkalinity, determination of chloride using Mohr's method.

### **Unit-5 : Industrial Waste Management 9 hours**

Waste water treatment - primary, secondary & tertiary treatment. (All treatment methods in detail). Characteristics of solid wastes, methods of solid waste treatment and disposal, microbiology involved in solid waste disposal, methods of solid waste disposal-composting, sanitary and filling - economic, aesthetic and environmental problems.

### **III. Suggested Co- Curricular Activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, discussions and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

### **IV. List of Reference books :**

- 1) E.Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK
- 2) J.A.Kent : Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- 3) P.C.Jain, M.Jain : Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- 4) R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- 5) B.K.Sharma : Engineering Chemistry, Goel Publishing House, Meerut
- 6) O.P.Vermani, A.K.Narula: Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.
- 7) A.K.De, Environmental Chemistry : NewAgeInternational Pvt, Ltd, NewDelhi.
- 8) C.k.Varshney:Water Pollution and Management,Wiley Eastern Limited, Chennai.
- 9) S.S. Dara and D.D. Mishra: Text book of Environmental Chemistry and Pollution Control, Revised edition, S.C.Hand & CoLtd.

## Course – 15- B Industrial Chemistry- Polymers and water analysis

Credits: 01

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### V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

- 1) Learn the procedures for the determination of BOD and COD.
- 2) Demonstrate skills in the determination of chloride in the given water sample.
- 3) Acquire skills in determining the hardness of water.
- 4) Analyse the soil samples
- 5) Handle pHmeter.

### VI. Laboratory course Syllabus:

- 1) Determination of Hardness of water by EDTA titration.
- 2) Determination of Chemical Oxygen Demand(COD)
- 3) Determination of Biological Oxygen Demand(BOD)
- 4) Determination of chloride using Mohr's method.
- 5) Determination of pH, turbidity and total solids in water sample.
- 6) Determination of  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  in soil sample by flame photometry.
- 7) Determination of pH in soil samples using pHmetry.

### VII. Suggested Co-curricular activities

Mandatory: *(Student training by teacher in field related skills: inlab: 15, in field: 05 hours):*

- 1) For Teacher: Training of students by the teacher in laboratory and field for not less than 15 hours on the field related skills in the determination of hardness of water, estimation of COD and BOD in water sample, determination of chloride ion in water sample.

- 2) For Student: Student shall visit a related industry /chemistry laboratory in universities/research organizations /private sector facility and observe the measurement of water quality parameters. Write their observations and submit a hand written field work / project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork/project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- 5) Unit tests (IE).

### **VIII. List of Reference books :**

- 1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
- 2) Text book on Experiments and Calculations in Engineering Chemistry, S.S.Dara, S.Chand.

**Note-1:** For SEMESTER –VII & VIII, for the domain subject Chemistry, Three Core courses and Two Skill Enhanced Courses shall be chosen course A or B from the list of Courses in each SEMESTER. Three pairs of Core Courses are 16A&16B, 17A&17B, 18A&18B for Sem- VII and 21A & 21 B, 22 A& 22 B and 23 A& 23 B in Sem-VIII.

Two Pairs of Skill Enhanced Courses are 19A&19B, 20A&20 B for Sem-VII and 24A & 24 B, 25A&25 B from Sem- VIII

One Online Course chosen from Swayam/NPTEL/Any other courses recognized by universities per SEMESTER -VII and VIII.

**Note-2:** *One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the skills embedded in syllabus citing related real field situations.*



- 1) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
- 2) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
- 3) ReactionMechanisminOrganicChemistry,S.M.MukherjiandS.P.Singh,Macmillan.
- 4) Basic Principles of Organic Chemistry by J.B.Roberts and M. Caserio.
- 5) Stereochemistry of Organic compounds by Ernest L.Eliel, Samuel H.Wilen
- 6) Chemistry of natural products byS.V.Bhat ,B.A.Nagasampangi.
- 7) Stereochemistry of Organic compounds by D.Nasipuri.

