ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

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
		OR		
	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
		OR		
	13 B	Green Chemistry and Nanotechnology	3	3
		Green Chemistry and Nanotechnology	2	1
	14 A	Synthetic Organic Chemistry		
		Synthetic Organic Chemistry		
		OR		
	14 B	Industrial Chemistry- Fertilisers and Surface coatings		

		Industrial Chemistry- Fertilisers and Surface coatings		
	15 A	Analysis of Organic Compounds		
		Analysis of Organic Compounds		
		OR		
	15 B	Industrial Chemistry- Polymers and water analysis		
		Industrial Chemistry- Polymers and water analysis		
VI		Internship		
VII	16 A	Inorganic Chemistry:Advance Studies in Complexes and Group theory	3	3
		Inorganic Chemistry:Advance Studies in Complexes and Group theory	2	1
		OR		
	16 B	Inorganic Materials of Industrial importance	3	3
		Inorganic Materials of Industrial importance	2	1
	17 A	Spectroscopy of Organic compounds	3	3
		Spectroscopy of Organic compounds	2	1
		OR		
	17 B	Stereo Chemistry and Natural Products	3	3
		Stereo Chemistry and Natural Products	2	1
	18 A	Physical Chemistry: Thermo dynamics, Electro chemistry and Chemical Kinetics.	3	3
		Physical Chemistry: Thermo dynamics, Electro chemistry and Chemical Kinetics.	2	1

		OR		
	18 B	Instrumental Methods of Chemical Analysis	3	3
		Instrumental Methods of Chemical Analysis	2	1
SEC	19 A	Green Chemistry	3	3
		Green Chemistry	2	1
		OR		
	19 B	Analysis of Drugs, Foods, Dairy Products& Bio Chemical Analysis		
		Analysis of Drugs, Foods, DairyProducts& Bio Chemical Analysis		
	20 A	Polymer Chemistry		
		Polymer Chemistry		
		OR		
	20 B	Industrial Chemicals and Environment		
		Industrial Chemicals and Environment		
		Open Online trans disciplinary course		
VIII	21 A	Inorganic Chemistry: Metal Cluster, Electronic spectra of Complex compounds and Bio- inorganic chemistry		
		Inorganic Chemistry: Metal Cluster, Electronic spectra of Complex compounds and Bio- inorganic chemistry		
		OR		
	21 B	Organo metallic Chemistry		
		Organo metallic Chemistry		
	22 A	Modern Organic synthesis and Natural Products Modern		

		Modern Organic synthesis and Natural Products Modern		
		OR		
	22 B	Chemistry of Natural products		
		Chemistry of Natural products		
	23 A	Physical Chemistry: Quantum And Molecular Spectroscopy		
		Physical Chemistry: Quantum And Molecular Spectroscopy		
		OR		
	23 B	Analytical Methods of Analysis		
		Analytical Methods of Analysis		
SEC	24 A	Pharmaceutical and Medicinal Chemistry		
		Pharmaceutical and Medicinal Chemistry		
		OR		
	24 B	Pesticides and Green Chemistry		
		Pesticides and Green Chemistry		
	25A	Corrosion and Its Prevention		
		OR		
		Corrosion and Its Prevention		
	25 B	Material & Energy Balances and Utilities in Chemical Industry		
		Material & Energy Balances and Utilities in Chemical Industry		
		Open Online trans disciplinary course		

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

efinition 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

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, duel 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 ΔH_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)

Valance Bond theory-arrangement of electrons in molecules, hybridization of atomic orbitals and geometry of molecules-$BeCl_2$, BF_3, CH_4, PCl_5, SF_6– VSEPR model-effect of bonding and nonbonding electrons on the structure of molecules, effect of electronegativity,

isoelectronic principle, illustration of structures by VESPR model-NH_3, H_2O, SF_4, ICl^-, ^{4}

ICl^{-2}, XeF_4, XeF_6

Molecular orbital theory -LCAO method, construction of M.O. diagrams for homo-nuclear and hetero-nuclear diatomic molecules (N_2, O_2, CO and 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 andSoft-Soft combinations.

List of Reference Books:

1. J. D. Lee, Concise Inorganic Chemistry, 5th 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, 3rd ed., W. H. Freeman and Co, London,

II - SEMESTER

Course Code 3: GENERAL AND INORGANIC CHEMISTRY

Credits: 01

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 Quanlitative Inorganic Analysis, Seventh edition, Pearson.

II - SEMESTER

Course Code 4: INORGANIC CHEMISTRY- I

Credits: 03

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 $(BN)_x$ Group14: Preparation, classification and uses of silicones and Silanes. Group 15: Preparation & structure of Phosphonitrilic Chloride $P_3N_3Cl_6$

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

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 Quanlitative Inorganic Analysis, Seventh edition, Pearson.

III -SEMESTER

Course Code 5: FUNDAMENTALS IN ORGANIC CHEMISTRY

Credits: 03

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- and1,4-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_2 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. (PearsonEducation).

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^{th} edition,1985.

III -SEMESTER

Course Code 5: Organic Qualitative analysis

Credits: 01

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

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 1^0,2^0,3^0alcohols 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°, 2°, 3°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, $NaHSO_3$ and alcohols. addition-

elimination reactions with hydroxylamine, hydrazine, phenyl hydrazine, 2,4DNP, semicarbazide. Oxidations and reductions (Clemmensen's, Wolf–Kishner's, with$LiAlH_4$ & $NaBH_4$).

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-COOHgroups, formation of salts, esters, acidchlorides, amides and anhydrides. Degradation of carboxylic acids by Huns-Diecker'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, α,β-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. (PearsonEducation).

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 6th edition,1985.

III - SEMESTER

Course Code 6: Organic preparations

Credits: 01

Organic preparation

Course outcomes:

On the completion of the course, the student will b eable 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 β-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

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_2O 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 boing 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

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_3COOH 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^{rd}Edition) –A.I.Vogel

2) Web related references suggested by teacher.

III -SEMESTER

COURSE CODE 8: INORGANIC AND PHYSICAL CHEMISTRY

Credits: 03

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. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

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, 6th edition, 2019.

III - SEMESTER

COURSE CODE 8: QUALITATIVE INORGANIC ANALYSIS

Credits: 01

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

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

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(3rd Edition) –A.I.Vogel

2) Web related references suggested by teacher.

IV - SEMESTER

Course Code 10: GENERAL AND PHYSICAL CHEMISTRY

Credits: 03

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

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 $KMnO_4$ with oxalic acid as primary standard. (internal indicator method)
4. Determination of Fe (II) using $KmnO_4$ with oxalic acid as primary standard. (external indicator method)
5. Estimation of water of crystallization in Mohr's salt by titrating with $KmnO_4$

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^{rd}Edition) –A.I.Vogel
2. Web related references suggested by teacher.

IV - SEMESTER

Course Code 11: Nitrogen containing Organic Compounds & Spectroscopy

Credits: 03

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 teritiary 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

λ_{max} of conjugated dienes and α,β 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 FinarVol 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

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

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

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 exceeding10pages 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

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
3) ecosystems services.
4) Engage in simple and advanced analytical tools used to measure the different types of pollution.
5) Explain the energy crisis and different aspects of sustainability.
6) Analyze key ethical challenges concerning biodiversity and understand the moral principles, goals
7) 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 dissolvedsolids,alkalinity–Hardnessofwater–Methodstoconverttemporaryhardwaterintosoft 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–Functionsandtypesofecosystem– Abioticandbioticcomponents – 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 byW. 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

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 Ca^{+2} and 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 than15 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^{rd}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

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, $R_f$values, factors affecting $R_f$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 Fe^{+2}, $Mn^{+2}$and 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 byR.A.DayJr .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

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 lessthan15 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) VogelA.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) MannF.Gand Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

Course 13 B Green Chemistry and Nanotechnology.

Credits: 03

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_2: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

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 1^0 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 hand written fieldwork /project work report not exceeding10pages 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

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,alkylationandallylradical. 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-1and type-2reactions Paterno–Buchi reaction.

Unit-3 : Retrosynthesis 9 hours

Important terms in Retro synthesis with examples-Disconnection, Target molecule, FGI, Synthon, 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 using1, 3-Dithiane.

Unit-5 : Reagents in Organic Chemistry 9 hours

Oxidizing agents:PCC,PDC,SeO_2 (Riley oxidation), NBS.

Reducing agents : $LiAlH_4$(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

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 famine acids using paper Chromatography.
3) Prepare the TLC plates for TL 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 lessthan15 hours on the field techniques/skills of detection of N, Sand halogens using thegreen procedure, preparation of TLC plates, detection of organic compounds using Rf 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 workreportnotexceeding10 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) VogelA.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) MannF.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

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

Credits: 03

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

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) etermination 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 15hours 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 notexceeding10pagesinthe 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

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 Impactionization, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, Butaldehyde, Propionicacid.

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

2,2,3,3-Tetramethyl butane,Butane-2,3-dione,Propionicacid 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, Rfvalues and factors affecting Rfvalues. 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, Lamp man, 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

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 1^0amine 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 lessthan15 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 exceeding10 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) MannF.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

Course 15 B : Industrial Chemistry- Polymers and water analysis

Credits: 03

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_x, SO_x, 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.

V -SEMESTER

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

Credits: 01

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 Ca^{+2} and Mg^{+2} in soil sample by flame photometry.
7) Determination of pHin soil samples using pHmetry.

VII. Suggested Co-curricular activities

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

1) For Teacher: Training of students by the teacher in laboratory and field for not lessthan15hours 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 exceeding10pages 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.*

VII - SEMESTER

Course 16A: Inorganic Chemistry-I: Advance Studies in Complexes and Group theory

I. Course Learning Outcomes:

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

1) The student will understand the VSPER theory, symmetric and unsymmetric Hydrogen bonds ininorganic molecules.
2) Understanding the Crystal field theory and Jahn Teller Effects.
3) The Students will be able to understand the basics of molecular orbital theory and energetic ofhybridization.
4) The Students are able to understand the Jobs method, hard and soft acids and bases.
5) The students will acquire the knowledge of symmetry

II. Syllabus:

Unit-I: Chemistry of non- transition elements: 9 Hours

Inter halogen compounds, Halogen oxides and oxyfluorides, Clathrate compounds, Spectral and Magnetic properties of Lanthanides and Actinides. Analytical applications of Lanthanides and Actinides. Synthesis, properties and structure of B-N, S-N,P-N cyclic compounds. Intercalation compounds.

Metal π- complexes: preparation, structure and bonding in Nitrosyl, Dinitrogen and Dioxygen complexes.

Unit-II: Structure and Bonding: 9 Hours

pπ-dπ bonding, Bent's rule, Non-valence cohesive forces, VSEPR theory. Molecular Orbital theory, Symmetry of Molecular orbitals, Molecular orbitals in triatomic(BeH_2) molecules and ions (NO_2^-) and energy level diagrams. Application of MO theory to square planar

($PtCl_4^{2-}$) and octahedral complexes(CoF_6^{3-},$Co(NH_3)_6^{3+}$). Walsh diagrams for linear (BeH_2) and bent(H_2O)molecules.

Unit-III: Metal–ligand bonding: 9 Hours

Crystal Field Theory of bonding in transition metal complexes-Splitting of d-orbitals in octahedral, tetrahedral, square planar and Trigonal bipyramidal and Square pyramidal fields. Tetragonal distortions - Jahn-Teller effect. Applications and limitations of CFT. Experimental evidences for covalence in complexes. Molecular Orbital Theory of bonding for Octahedral, tetrahedral and square planar complexes. π-bonding and MOT - Effect of π - donor and π – acceptor ligands on Δo. Experimental evidence for π-bonding in complexes.

Unit-IV: Metal–ligand Equilibriain solutions: 9 Hours

Step wise and over all formation constants. Trends in stepwise constant(statistical effect and statistical ratio). Determination of formation constants by Spectrophotometric method (Job's method) and pHmetric method (Bjerrum's). Stability correlations-Irwing-William's series. Hard and soft acids and bases (HSAB),Acid-base strengths.

Unit- V: Group theory 9 Hours

Basic concepts of Symmetry and Group theory- Symmetry elements, symmetry operations and point groups. Schoenflies symbols-Classification of molecules into point groups–Axioms of Group theory– Group multiplication tables for C_2V and C_3V point groups–Similarity. Transformation and classes Representations–reducible and irreducible representations. Mulliken symbols, Orthogonality theorem and its implications,character table and it's anatomy.

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 industries, firms, research organizations etc.
4) Invited lectures and presentations on related topics by field/ industrial experts.

IV. List of Textbooks :

1) Inorganic Chemistry Huheey, Harper and Row.
2) Physical methods in inorganic chemistry,R.S.Drago.AffliatedEast-WestPvt.Ltd.
3) Concise inorganic chemistry, J.D.Lee, ELBS.
4) Modern Inorganic Chemistry, W.L.Jolly, McGrawHill.
5) Inorganic Chemistry,K.F.Purcell and J.C.KotzHolt Saunders international.
6) Concepts and method Of inorganic chemistry, B.E.Douglas and D.H.M.C. Daniel, oxford Press.
7) Introductory quantum Mechanics, A.K.Chandra.
8) Quantum Chemistry, R.K.Prasad.

V. Reference books:

1) Inorganic Chemistry, Atkins,ELBS.
2) Advanced Inorganic Chemistry,Cottonand Wilkinson,Wiley Eastern.
3) Text book of Coordination chemistry, K.Soma Sekhara Rao and K.N.K.Vani, Kalyani Publishers.
4) GroupTheory and its Applications to Chemistry, K.V.Raman, TataMcGraw– Hill Publishing Company Ltd., New Delhi.
5) Chemical Applications of Group Theory, F.A.Cotton Wiley Eastern Limited NewDelhi.

***Course 16A*: Inorganic Chemistry-I: Advance Studies in Complexes and Group theory practical Syllabus:**

VI. 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) Understand the basic concepts of qualitative analysis of inorganic mixture.
3) Apply the concepts of common ion effect, solubility product and concepts related to qualitativeanalysis..
4) Acquire skills in elimination interfering anion..
5) Identification of less familiar cation.

Syllabus:

1) Synthesis of Inorganic Metal Complexes:
2) Synthesis of 3d transition metal complexes of tetrahedral, square planar andoctahedral geometries.
3) Tetra ammine copper (II) sulphate monohydrate
4) Potassium tris (oxalato) ferrate(III) trihydrate
5) Tris (thiourea) copper(I) sulphate

Systematic Semi micro Qualitative Analysis of Inorganic six radical mixtures: In systematic Semi micro qualitative inorganic analysis, inorganic mixture contains three cations and three anions. The analysis involves identification and conformation ofcations and anions containing one less familiar cation (Tungsten, Molybdenum, Zirconium, Thorium, Titanium, Uranium, Cerium, Vanadium, Lithium, Berkelium etc.,) and one interfering anion.

Anions:

CO_3^{2-},S^{2-},SO_3^{2-},Cl^-,Br^-,I^-,NO_3^-,SO_4^{2-},CH_3COO^-, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$

,PO_4^{3-},CrO_4^{2-},AsO_4^{3-},F^-,BO_3^{3-}

Cations :

Ammonium ($NH_4^{+)}$

1st group: Hg, Ag, Pb, Tl, W

2nd group: Hg, Pb, Bi, Cu, Cd, As, Sb, Sn, Mo 3rd group: Fe, Al, Cr, Ce, Th, Ti, Zr, V, U, Be
4th group: Zn, Mn, Co, Ni

5th group: Ca, Ba, Sr
6th group: Mg, K, Li

Note: A minimum of 4 inorganic mixtures must be analysed in this SEMESTER .

VII. Sugggested 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 lessthan15 hours on the field techniques/skills of involves identification and conformation of cations and anions containing one less familiar cation and one interfering anion.

2) **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 exceeding10 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) Unittests(IE).

VIII. Reference Books:

1) Practical Inorganic Chemistry,G.Marr and B.W.Rockett.

2) Practical Inorganic Chemistry by G.PassH. Sutchiffe, 2nd edn JohnWiley & Sons.

3) Experimental Inorganic / Physical Chemistry, M.A.Malati, Horwood Publishing ,Chichester,UK(1999)

4) Vogel's text book of semi micro qualitative analysis, 5th Edition by G. Svehla.

VII - SEMESTER

Course 16B:Inorganic Materials of Industrial Importance

I. Course learning Outcomes:

By the end of the course, the students will be able to:

1. Learn the composition and applications of the different kinds of glass.
2· Understand glazing of ceramics and the factors affecting their porosity.

3· Give the composition of cement and discuss the mechanism of setting of cement.
4· Explain the suitability of fertilizers for different kinds of crops and soil.

5· Explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings.

6· Explain the principle, working and applications of different batteries.

7· List and explain the properties of engineering materials for mechanical construction used in day today life.

8· Explain the synthesis and properties of nano-dimensional materials, various semiconductor And superconductor oxides

II. Syllabus

Unit 1:Silicate Industries: **[9 hours]**

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture andprocessing of glass. Composition and properties of the following types of glasses: Soda lime glass, leadglass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass, colouredglass, photosensitive glass, photochromic glass, glass wool and optical fibre.

Ceramics: Brief introduction to types of ceramics. glazing of ceramics.

Unit 2:Fertilizers: [**9 hours]**

Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufactureof the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate,

ammonium phosphates,superphosphate of lime, potassium chloride and potassium nitrate.

Unit 3:Batteries:**[9 hours]**

Primary and secondary batteries, characteristics of an Ideal Battery, principle, working, applications andcomparison of the following batteries: Pb- acid battery, Li-metal batteries, Li

-ion batteries, Li-polymerbatteries, solid state electrolyte batteries, fuel cells, solar cells and polymer cells.

Unit 4:Synthesis of inorganic solids: [9 hours]

Conventional heat and beat method, Co-precipitation method, Sol-gel method, Hydrothermal method, Chemical vapor deposition (CVD), Ion-exchange and Intercalation method.

Unit 5:Nanomaterials: [9 hours]

Overview of nanostructures and nanomaterial's, classification, preparation and optical properties of gold and silver metallic nanoparticles, concept of surface Plasmon resonance, carbon nanotubes, inorganic nanowires, Bioinorganic nanomaterial's natural and artificial nanomaterial's, self-assembled nanostructures, control of Nano architecture, one dimensional control.

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts

IV. Suggested Text Books:

1. Poole Jr.; Charles P.; Owens, Frank J. (2003), **Introduction to Nanotechnology**, John Wileyand Sons

2. West, A. R. (2014),**Solid State Chemistry and Its Application**, Wiley

3. Smart, L. E.; Moore, E. A. (2012),**Solid State Chemistry An Introduction**, CRC PresTaylor &Francis.

4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010),**Shriver andAtkins Inorganic Chemistry**, W. H. Freeman and Company.

5. Kent, J. A. (ed**)** (1997),**Riegel's Handbook of Industrial Chemistry**, CBS Publishers, NewDelhi.

V. References:

1.Svehla, G.(1996),Vogel's Qualitative Inorganic Analysis, Prentice Hall.

2. Banewicz, J. J.; Kenner, C.T. Determination of Calcium and Magnesium in Limestones and Dolomites, Anal. Chem., 1952, 24 (7), 1186–1187.

VII: SEMESTER

Course 16B: Inorganic Materials of Industrial importance-

VI. Learning outcomes:

By the end of the course students will be able to:

1. Identify sulphate and ammonium ion present in ammonium sulphate fertilizer

2. Estimate the amount of calcium present in a fertilizer

3. Synthesize nanoparticles by chemical method

4. Synthesize metal doped metal oxide nanoparticles

5. Prepare and characterize silver nanoparticles.

VII. Practical Syllabus:

1. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) byqualitative analysis and determine its free acidity.

2. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer andestimation of Calcium content.

3. Synthesis of ZnO nanoparticles by chemical method and its characterization using UV-visible Spectrophotometer.4. Cu doped ZnO nanoparticles

5. Synthesis of silver nanoparticles by green methods and its characterizationusing UV-visible Spectrophotometer.

6. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) and Determination of composition of Dolomite (Complexometric titration).

VIII. 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 than15 hours on the field techniques/skills of synthesis of nanoparticles and its characterization using various techniques.

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the stages in cement preparation. 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. Unittests(IE).

IX. References:

1. Ghorbani, H. R.; Mehr, F.P.; Pazoki, H.; Rahmani B. M. Synthesis of ZnO Nanoparticles by Precipitation Method. Orient J Chem. 2015;31(2).

2. Orbaek, W.; McHale, M.M.; Barron, A.R. Synthesis and characterization of silver nanoparticles for an undergraduate laboratory, J. Chem. Educ. 2015, 92, 339−344.

VII -SEMESTER

Course 17A:Spectroscopy of Organic compounds

I. Learning Outcomes:

By the end of the course, the students will be able to:

1) Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.

2) Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules

3) Interpret of IR, UV-visible spectra and their applications

4) Interpret of NMR, Mass spectra and their applications

5) Interpret the spectra in identifying the organic compounds

II. Syllabus

Unit-I **[9 hours]**

UV-Vis Spectroscopy

Energy transitions – Simple chromophores – UV absorption of Alkenes –polyenes unsaturated cyclic systems – Carbonyl compounds, α,β-unsaturated carbonylsystems - Woodward Fieser rules – aromatic systems – solvent effects – geometricalisomerism – acid

and base effects – typical examples – calculation of λ_{max} values usingWoodward - Fieser rules.

b) **ORD:** Theory of optical rotatory dispersion, α-Axial haloketone rule and octant rule –

Application of these rules in the determination of absolute configuration of cyclohexanones, decalones and cholestanones.

Unit-II **[9 hours]**

Infrared Spectroscopy (FT-IR): Fundamental modes of vibrations – Stretching and bending vibrations – overtones, combination bands and Fermi resonance, factors influencing vibrational frequencies, hydrogen bonding – fingerprint region and its importance – Study of

typical group frequencies for – CH, -OH, -NH, -CO-NH_2, -CC, -CHO, -CO and aromatic systems. Application in structural determination –Simple problems

Unit-III **[9 hours]**

^{1}H NMR spectroscopy:

a) Magnetic properties of Nuclei, Nuclear resonance, Fourier Transformation and its importance in NMR. Equivalent and non-equivalent protons, The chemical shift and it's importance, calculation of chemical shift, factors affecting the chemical shifts such as electronegativity and anisotropy, effect of deuteration, Signal integration, Spin-spin coupling: vicinal (Karplus relationships), germinal and long range. Coupling constants (*J*) and factors affecting coupling constants. –Shielding and deshielding mechanisms in acetylene carbonyl and Benzene, anisotropy –Spin-Spin Interactions related to first order and higher order spectra (AB, A_2; AB_2, ABX, ABC, AMX) –temperature dependence spectra, Hydrogen bonding.

Unit-IV **[9 hours]**

Electron Spin Resonance Spectroscopy (**ESR**):

Basic Principles, Comparison of NMR &ESR.Determination of 'g' value, Factors affectingthe 'g' value.Isotropic and Anisotropic constants.Splitting, hyperfine splitting couplingconstants. Line width, Zero field splitting, and Kramer degeneracy. Crystal field splitting,Crystal field effects.

Applications: Detection of free radicals; ESR spectra of(a) Methyl radical (CH3·), (b) Benzene anion (C6H6-).

UNIT-V

MASS SPECTROMETRY [9 hours]

Introduction, ion production, type of ionization, EI, CI, FD, and FAB-factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular-ion peak, metastable peak, Mac Lafferty rearrangement. Nitrogen rule, isotope labeling. High resolution mass spectrometry, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1. Organic spectroscopy, W. Kemp 5th Ed, ELBS

2. Spectroscopy of organic compounds, RM Silversteen and others, 5th Ed,John Wiley

3. Spectroscopy of organic compounds, P.S. Kalsi, Wiley, 1993.

V. References:

1. NMR in chemistry-A multi nuclear introduction, William Kemp, McMillan, 1986.

2. Spectroscopic methods in Organic chemistry, DH Williams & I Flemmi

Course 17A: Spectroscopy of Organic Compounds- Practical Syllabus

VI. Learning outcomes:

By the end of the course students will be able to

1. Identify the functional groups present in the molecules

2. Apply data to in identification of the molecule

3. Describe principles involved in Spectroscopic methods

4.Predict number of signals, splitting patterns in the proton NMR of a compound

5.Develop ability in the combined use of mass spectrometry and spectroscopic techniques for structure elucidation

VII. Practical Syllabus

a) Problems involving individual spectral methods – UV, IR, PMRand Mass

b) Problems involving combined any two of UV, IR, PMRand Mass

c) Problems involving combined any three of UV, IR, PMRand Mass

c) Problems involving all four UV, IR, PMR and Mass spectral data.

VIII. 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 than15 hours on the field techniques/skills of detection of organic compounds using spectroscopic data.

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reaction and obtaining spectral data and analyzing the 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).

IX. References:

1. NMR in chemistry-A multi nuclear introduction, William Kemp, McMillan, 1986.

2. Spectroscopic methods in Organic chemistry, DH Williams & I Flemmi

VII - SEMESTER

***Course 17 B*: Organic Chemistry: Stereo Chemistry and Natural Products**

I. Course Learning outcomes:

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

1) Understand and apply the substitution and elimination reaction mechanisms at aliphaticand aromatic substrates for various reactions leading to research
2) Write the stereo chemical forms for different organic molecules.
3) Understand the conformations of acyclic, monocyclic and fused ring systems and applying it toorganic compounds.
4) Explain formation of various heterocyclic compounds and their synthesis and importance.
5) Describe the importance of natural products in medicinal chemistry

II. Syllabus:

Unit – I Reaction Mechanism **9 Hours**

Aliphatic Nucleophilic Substitution and Nucleophilic Aromatic substitution:

Stereo chemistry of $SN_2$and SN_1mechanisms, Neighboring Group Participation (Anchimeric assistance), NGP by O, S, N : Aromatic Nucleophilic substitution SN2 (Ar) (Addition – Elimination), SN1(Ar) and benzyne mechanisms (Elimination - Addition); evidence for the structure of benzyne. Von Richter Sommelet-Hauser rearrangements.

Elimination Reactions:

Type of elimination reactions, mechanisms, Stereochemistry and Orientation, Hofmann and Saytzeff rules, Syn elimination versus anti-elimination,competition between elimination and substitution, dehydration, dehydrogenation, dehalogenation, decarboxylative eliminations and pyrolytic eliminations

Unit-II: Stereo Chemistry-I: **9 Hours**

Concept and Recognition of Molecular Symmetry and Chirality. Definition and classification of Stereoisomers, Enantiomer, Diastereomer, Homomer, Epimer, Anomer, Configuration and

Conformation, Configurational nomenclature: D,L and R,S nomenclature. Molecular representation of organic molecules: Fischer,Newman and Sawhorse projections and their inter-conversions. Geometrical Isomerism. Cis-trans, E, Z-and Syn and anti nomenclature, Methods of determining configuration of Geometrical isomers using physical, spectral and chemical methods, Stability, Cis-trans interconversion.

Unit-III: Stereo Chemistry-II: 9 Hours

Conformation and factors influencing on stability of Conformations; Conformational analysis of cyclic molecules - cyclobutane, cyclohexane – mono and disubstituted cyclohexanes and carbon heteroatom bonds having C–O&C–N. Prochirality and

Prostereoisomerism:-Homotopic ligands and faces; enantiotopic ligands and faces; diastereotopic ligands and faces; nomenclature of enantiotopic ligands and faces(Pro-R, Pro- S, Re, Si carbonyl compounds and Alkenes)

Stereoisomerism in molecules without chiral Center Axial chiralityAllenes, Alkylidene cycloalkanes, spiranes. Atropisomerism: Biphenyl derivatives, nomenclature. Planar chirality: Ansa compounds, paracyclophanes, trans-cyclooctene and Helicity.

UNIT–IV Heterocyclic compounds 9 Hours

Importance of heterocyclic compounds as drugs. Nomenclature of heterocyclic systems based on ring size, number and nature of hetero atoms. Chemistry of heterocyclic compounds, synthesis and reactivity of the following systems: Quinoline, Isoquinoline, Indole, Pyrazole, Imidazole, Oxazole, Isoxazole, Pyridazine, pyrimidine and Pyrazine.

UNIT- V Chemistry of some typical natural products 9Hours

Isolation, classification, structure elucidation, synthesis of:

Alkaloids: Atropine, Nicotine, and Quinine.

Terpenoids: α-Terpeneol, α-Pinene and Camphor.

III. Suggested Co- Curricular Activities

1) Training of students by related industrial experts.

2) Assignments, Seminars and Quiz (on related topics), collection ofrelevant 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 Textbooks:

1) Advanced organic chemistry-Reaction, mechanism and structure, Jerry March, John Wiley.

2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Springer, NewYork.

3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.

4) Organic chemistry, I.L.Finar, Vol.I, Fifth edi . ELBS.

5) Organic chemistry, Hendrickson,Cram and Hammond (McGraw–Hill).

V. Reference books:

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.

Course No 17 B : ORGANIC CHEMISTRY PRACTICALS

VI. 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) Acquire skills in the separation of organic compounds in the given mixture using solvent extraction.
3) Determine the Melting and Boiling points of Organic compounds.
4) Understand the application of concepts of different organic reactions studied in the theory partof Organic chemistry.

VII. Syllabus.

Systematic qualitative analysis of an organic mixture containing two compounds; Identification of method of separation and the functional group(s) present in each of them and preparation of one solid derivative for the conformation of each of the functional group(s).Purification of derivatives- The student has to do Recrystallization to final derivatives(s) and submit the sample. If the sample is impure liquid must carry out distillation process.

VIII. 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 lessthan15 hours on the field techniques/skills of separation of the given organic mixture, identifying and confirming the functional group followed by the preparation of recrystallized solid derivative.
2) **For Students**: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observesthe synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding10 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).

IX. Reference Books:

1) Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D.Barnes and M. J. Thomas, 4th& 6th Ed. (Pearson Education Asia).

2) Vogel's Text Book of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, P.W.G.Smith, A.R. Tatchell, 5 Ed.(Longman Scientific & Technical).

VII - SEMESTER

***Course 18A*:Physical Chemistry – I :Thermodynamics, Electrochemistry andChemical Kinetics**

I. Course Learning outcomes:

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

1) Understand the classical thermo dynamics, fugacity.
2) Describe the Electrochemical cells, Liquid junction potential.
3) Derive the Butler - Volmer equation and Ilkovic equation
4) Understand the complex reactions, chain reactions.
5) Demonstrate the Branching Chain Reactions, Enzyme catalysis and Photochemical equilibrium.

II. Syllabus

Unit-I: Thermodynamics: 9 Hours

Classical thermodynamics - Entropy change in reversible and irreversible processes - Entropy of mixing of ideal gases - Entropy and disorder – Free energy functions - Gibbs-Helmholtz equation – Maxwell partial relations. Conditions of equilibrium and spontaneity - Free energy changes in chemical reactions, Van't Hoff reaction isotherm - Van't Hoff equation – Classiuss

- Clapeyron equation -partial molar quantities - Chemical potential - Gibbs- Duhem equation

- partial molar volume -determination of partial molar quantities - Fugacity - Determination of fugacity – Thermodynamic derivation of Raoult'slaw.

Unit-II: Electrochemistry-1: 9 Hours

Electrochemical cells - Measurement of EMF - Nernst equation –Equilibrium constant from EMF Data - pH and EMF data - Determination of solubility product from EMF measurements. Concentration cells with and without transference – Liquid junction potential and its determination -Activity and activity coefficients - Debye Huckel limiting law and its

verification. Effect of dilution on equivalent conductance of electrolytes - Anomalous behavior of strong electrolytes. Debye Huckel – Onsagar equation-verification and limitations-Bjerrum treatment of electrolytes.

Unit-III: Electro Chemistry-II: 9 Hours

Reference electrode - Standard hydrogen electrode. Calomel electrode-Indicator electrodes: Metal- metal ion electrodes – Inert electrodes-Membrane electrodes - theory of glass membrane potential, potentiometric titrations, Conductometric titrations. Electrode potentials - Double layer at the interface - rate of charge transfer - Decomposition potential – Over potential - Tafel plots - Derivation of Butler- Volmer equation for one electron transfer – electro chemical potential.

Unit-IV :Chemical kinetics and Photochemistry: 9 Hours

Branching Chain Reactions- Hydrogen-oxygen reaction - lower and upper explosion limits - Fast reactions - Study of kinetics by flow methods -Relaxation methods - Flash photolysis. Acid base catalysis –protolytic and prototropic mechanism. Enzyme catalysis-Michelis-Menten kinetics.

Photochemistry: Quantum yield and its determination, Actinometry, Reactions with low and high quantum yields, Photo sensitization, Exciplexes and Excimers,Kinetics of collisional quenching- Stern-Volmer equation.

Unit-V: Chemical kinetics - II: 9Hours

Methods of deriving rate laws - complex reactions - Rate expressions for opposing, parallel and consecutive reactions involving unimolecular steps. Theories of reaction rates - collision theory-Steric factor-Activated complex theory -Thermo dynamic aspects– Unimolecular reactions- Lindemann's theory -Lindemann Hinshelwood theory. Primary and secondary salt effects. Elementary account of linear free energy relationships - Hammet-Taftequation - Chain reactions - Rate laws of H_2-Br_2, photochemical reaction of H_2 - Cl_2. Decomposition of acetaldehyde and ethane- Rice-Hertzfeld mechanism.

III. Suggested Co- Curricular Activities:

1) Training of students by related industrial experts.

2) Assignments, Seminars, discussions and debates 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 Textbooks:

1) Physical Chemistry P.W.Atkins, ELBS.

2) Chemical Kinetics -K.J.Laidler,McGraw Hill Pub.

3) Text Book of Physical Chemistry. Samuel Glasstone, Mcmillan Pub.

4) Physical Chemistry, G.W.Castellan.Narosa Publishing House

V. Reference books:

1) Thermodynamics for Chemists.Samuel Glasstone.

2) Electro chemistry,Samuel Glasstone,Affiliated East West

3) Physical Chemistry, W.J.Moore, Prentice Hall

Course 18A : PHYSICAL CHEMSITRY PRACTICALS –I

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 and apply the concepts of electro chemistry in experiments.
3) Be familiar with electro analytical methods and techniques which study an analyte by measuring the potential (volts) and / or current (amperes) in an electro chemical cell containing the analyte..
4) Learn the procedures of preparation of standard solutions.
5) Acquire skills in operation and calibration of instruments..

Syllabus:

1) Conductometric titration of Strong acid versus Strong base
2) Dissociation constant of weak acid (CH_3COOH) by conductometric method.
3) Conductometric titration of Weak acid vs Strong base.
4) Determination of cell constant
5) Acid-catalyzed hydrolysis of methyl acetate
6) Determination of partial molar volume of solute –H_2O system by apparent molar volume method.

Suggested Co-CurricularActivities

Mandatory:*(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

1) **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of handling conductometric titrations.
2) **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 field

work/project work report not exceeding10 pagesin the given format to the teacher.

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

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

5) Unit tests(IE).

VI. Reference book:

1) Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnesand M. J. Thomas, 4^{th}& 6^{th} Ed. (Pearson Education Asia).

VII - SEMESTER

Course 18 B: Instrumental Methods of Chemical Analysis

I. Learning Outcomes

By the end of the course, the students will be able to:

1) Handle analytical data

2) Understand basic components of IR, FTIR, UV-Visible and Mass spectrometer.

3) Interpret of IR, FTIR, UV-visible spectra and their applications.

4) Understand the use of single and double beam instruments.

5) Learn elemental analysis, Electro analytical Methods, Radiochemical Methods, X-ray analysis and electron spectroscopy

II. Syllabus:

Unit-I: Introduction to analytical methods of data analysis and Electroanalytical Methods: **[9 hours]**

Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiations.

Potentiometry & Voltammetry.

Unit –II: Molecular spectroscopy [9 hours]

Infrared spectroscopy: Interaction of radiations with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution),and advantages of Fourier-Transform Infrared (FTIR) spectroscopy.

Applications: Issues of quality assurance and quality control, special problems for portable instrumentation and rapid detection.

Unit- III:UV-Visible/ Near IR Spectroscopy [9hours]

Emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution),wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers,

diode arrays, sensitivity and S/N),Single and double beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time).

Unit–IV: Mass spectroscopy [9 hours]

Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ionson basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrapole. Resolution, time and multiple separations, detection and interpretation.

Unit –V: Elemental analysis [9 hours]

Atomic spectroscopy**:** Atomic absorption, atomic emission, and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas),

wavelength separation and resolution (dependence on technique), detection of radiation (simultaneous/scanning, signal noise),interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr.(2004), **Instrumental methods of analysis**, 7th edition, CBS Publishers.

2. Skoog, D.A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**, Thomson Brooks/Cole.

3. Banwell, C.N. (2006),**Fundamentals of Molecular Spectroscopy**,Tata McGraw-Hill Education

V. Reference Books:

1. Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**, Cengage Learning.

2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.

Course 18 B: Instrumental Methods of Chemical Analysis-Practical Syllabus

VI: Course learning outcomes

By the end of the course students will be able to

1) Determine the isoelectric pH of a protein

2) Identify the functional groups present in organic compounds

3) Estimate the amount of chloride and iodide present in the solution

4) Recognize the quality of water

VII. Practical-Syllabus

1. Determination of the isoelectric pH of a protein.

2. Titration curve of an amino acid

3. IR absorption spectra (study of aldehydes and ketones)

4. Potentiometric titration of a chloride-iodide mixture

5. Potentiometric Titration of Metal Ions in Ethanol

6.Estimation of Alkalinity, BOD and COD

VIII. Co-Curricular Activities:

a) Mandatory:*(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

1. **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of detection of organic compounds using spectroscopic data.

2. **ForStudents**:Student shall visit a related industry/ chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reactions and obtain spectral data for interpretation of the synthetic compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding10

3.

4. pages in the given format to the teacher.

5. Max. marks for Fieldwork/project work Report:05.

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

7. Unittests(IE).

IX. References:

1. Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**, Cengage Learning.

2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.

VII - SEMESTER

Skill Enhancement Course

Course 19 A: Green Chemistry

I. Learning Outcomes:

By the end of the course Students will be able to:

1. Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances·

2. Understand stoichiometric calculations and relate themto green chemistry metrics.

3. They will learn about atom economy and how it is different from percentage yield.

4. Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you"

5. Understand benefits of use of catalyst and bio catalyst,use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, and importance led reactions in various green solvents.

6. Appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus the students are able to realize that chemistry can be used to solve rather than cause environmental problems.

7. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real world cases also motivate them to practice green chemistry.

II. Syllabus:

Unit 1:Introduction to Green Chemistry [9 hours]

What is Green Chemistry? Some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Unit 2:Principles of Green Chemistry and Designing a Chemical synthesis [9 hours]

Twelve principles of Green Chemistry and their explanation with examples

Special emphasis on the following:

Prevention of Waste/ by products; maximum incorporation of the materials used in the process into the final products, Environmental impact factor, waste or pollution prevention hierarchy. Green metrics to assess greenness of a reaction, e.g. Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity. Risk = (function) hazard x exposure. Designing safer chemicals with minimum toxicity yet has the ability to perform the desired functions. Green solvents: super critical fluids with special reference to carbon dioxide, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, solvents obtained from renewable resources and how to compare greenness of solvents. Energy requirements for reactions – alternative sources of energy: use of microwaves,

Ultrasonic energy and photochemical energy. Selection of starting materials; should be renewable rather than depleting, Illustrate with few example such as biodiesel and polymers from renewable resources (such as green plastic). Avoidance of unnecessary derivatization – careful use of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis andgreen chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

Unit 3:Examples of Green Synthesis/ Reactions [9 hours]

Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative toStrecker synthesis).Green Reagents: Non-phosgene Isocyanate Synthesis, Selective Methylation using Dimethylcarbonate. Microwave assisted solvent free synthesis of copper phthalocyanine. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid. AndDecarboxylation reactionUltrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)

Unit 4: [9 hours]

Real world case studies based on the Presidential green chemistry awards of EPA Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. A new generation of environmentally advanced wood preservatives: Getting the chromium and Arsenic out of pressure treated wood. An efficient, green synthesis of a compostable and widely applicable

plastic (polylactic acid) made from corn. Healthier Fats and oils by Green Chemistry: Enzymatic Inter esterification for production of No Trans-Fats and Oils.

Unit 5:Future Trends in Green Chemistry [9 hours]

Oxidation reagents and catalysts; Biomimcry and green chemistry, Biomimetic, Multifunctional Reagents; mechanochemical and solvent free synthesis of inorganic complexes; co crystal controlled solid state synthesis(C_2S_3); Green chemistry in sustainable development.

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1. Anastas, P.T.; Warner, J.C.(1998),**Green Chemistry, Theory and Practice,** Oxford University Press.

2. Lancaster, M.(2016),**Green Chemistry An Introductory Text.**2nd Edition, RSC Publishing.

3. Cann , M. C. ;Connely,M. E.(2000), **Real-World cases in Green Chemistry,** American Chemical Society,Washington.

4. Matlack, A.S.(2001),**Introduction to Green Chemistry,** Marcel Dekker.

5. Alhuwalia,V. K.; Kidwai, M.R.(2005),**New Trends in Green chemistry**, Anamalaya

Publishers

V. References:

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment.** AmericanChemical Society, Washington DC.

2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), **Green Chemistry Experiments: A monograph,** I.K.International Publishing House Pvt Ltd. New Delhi.

3. Pavia,D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),**Introduction to organic Laboratory Technique-A Micro-scale approach**,4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.

VII - SEMESTER

Skill Enhancement Course

Course 19 A: Green Chemistry practical

Learning Outcomes:

By the end of the course students will be able to

1. Synthesize nanoparticles using green methods

2. Prepare biodiesel form waste cooking oil

3. Synthesize inorganic complexes using green methods

4. Synthesize benzopinacol in the presence of sunlight

VI. Practical Syllabus

1. Preparation and characterization of nanoparticles of CuO/ ZnO nanoparticles using plant extracts.

2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, Solubility, Combustion Test,Density, Viscosity.

3. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).

5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

6. Spot tests for qualitative inorganic analysis for cations and anions, and qualitative organic analysis for preliminary test and functional group analysis.

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 than15 hours on the field techniques/skills of green methodologies in place of

polluting solvents/chemicals

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the green synthetic methods adopted in the industry. 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. Unittests(IE).

VIII. References:

1. Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of usefulproducts from waste further generated. Indu Tucker Sidhwaniet al. University of Delhi, Journal ofUndergraduate Research and Innovation, Volume 1, Issue 1,February 2015, ISSN: 2395-2334.

2. Sidhwani, Tucker I.; Chowdhury, S. Greener alternatives to Qualitative Analysis for Cations withoutH_2S and other sulfur containing compounds, J. Chem. Educ. 2008, 85, 1099.

3. Sidhwani, Tucker I.; Chowdhury, S. et al., DU Journal of Undergraduate Research and Innovation,2016, Volume 2, Issue 2, 70-79.

4. Dhingra, S., ;Angrish, C. Qualitative organic analysis: An efficient, safer, and economical approach to preliminary tests and functional group analysis. *Journal of ChemicalEducation*, 2011, *88*(5), 649-651.

VII - SEMESTER

Skill Enhancement Course

Course 19 B: Analysis of Drugs,Foods,DairyProducts&Bio-Chemical Analysis

I. Learning Outcomes:

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

1. Explain the principles of formulation and application of Drugs.
2. Acquire a critical knowledge on synthetic techniques of drugs.
3. Demonstrate the skills in analysis of **Foods,DairyProducts.**
4. Comprehended the applications of **Bio-ChemicalAnalysis**.
5. Acquire a critical knowledge on analysis of **Foods,DairyProducts.**

II. Syllabus)

UNIT- I **9 hours**

Analysis of the following drugs and pharmaceuticals preparations: (Knowledge of molecular formula, structure and analysis): Analysis of analgesics and antipyretics like aspirin and paracetamol ,Analysis of antimalerials like choloroquine, Analysis of drugs in the treatment of infections and infestations: Amoxycillin, chloramphenicol, penicillin, tetracycline.

UNIT- II **9 hours**

Analysis of the following drugs and pharmaceuticals preparations :(Knowledge of molecular formula, structure and analysis):

Analysis of antihistamine drugs and sedatives like: allegra, zyrtec (citirizine), alprazolam, trazodone, lorazepem, ambien(zolpidem).

UNIT- III **9 hours**

Analysis of anti epileptic and anti convulsant drugs like phenobarbital and phenacemide.Analysis of drugs used in case of cardiovascular drugs:atenolol,norvasc(amlodipine),Analysis of lipitor(atorvastatin) a drug for the prevention of production of cholesterol.

Analysis of diuretics like: furosemide (Lasix), triamterene

Analysis of prevacid(lansoprazole)a drug used for the prevention of production of acids in stomach.

UNIT- IV **10 hours**

Analysis of Milk and milk products:Acidity,total solids,fat,total nitrogen,protenines, lactose, phosphate activity, casein, choride. Analysis of food materials-Preservatives :Sodium carbonate, sodium benzoate sorbicacid. Coloring matters –Briliant blue FCF, fastgreenFCF, tertrazine, erytrhosine, sunset yellowFCF.

Flavoring agents - Vanilla , diacetyl, isoamyl acetate, limonene, ethyl propionate , allyl

hexanoate and Adulterants in rice and wheat, wheat floor, sago, coconut oil, coffee powder, tea powder, milk.

UNIT-V **8 hours**

Clinical analysis of blood: Composition of blood,clinical analysis, trace elements in the body. Estimation of blood chlolesterol, glucose,enzymes, RBC&WBC,Blood gas analyser.

III. Suggested Co-Curricular Activities

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

IV. Text Books:

1. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.

2. Foye's Principles of Medicinal Chemistry.

3. Burger's Medicinal Chemistry, Vol I to IV.

4. Introduction to principles of drug design- Smith and Williams.

V. References Books:

1. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.

2. Foye's Principles of Medicinal Chemistry.

3. Burger's Medicinal Chemistry, Vol I to IV.

4. Introduction to principles of drug design- Smith and Williams.

5. Remington's Pharmaceutical Sciences.

6. Martindale's extra pharmacopoeia.

7. Organic Chemistry by I.L. Finar, Vol. II.

8. The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.

9. Text book of practical organic chemistry- A.I.Vogel.

Course 19B. AnalysisofDrugs,Foods,DairyProducts&Bio-ChemicalAnalysis-PracticalSyllabus

VI. Learning Outcomes:

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

1. Develop comprehensive product development programs to meet new product criteria and timing.
2. Acquire skills in the Analysis of Drugs,foods and Dairy Products.
3. Demonstrate proficiency in the experimental techniques of biomedical chemical
4. Carry out food testing with the knowledge of foods.
5. Learn the procedure of synthesis of drugs.
6. Critically develop, apply, report, interpret and reflect on strategies for collecting data in the lab and field.

VII. Practical (Laboratory) Syllabus:

1. Preparation of Aspirin
2. Preparation of Paracetamol
3. Preparation of Acetanilide
4. Preparation of BarbutiricAcid
5. Preparation of Phenyl Azo β-naphthol

VIII. References Books:

1. Introduction to principles of drug design- Smith and Williams.
2. Remington's Pharmaceutical Sciences.
3. Martindale's extra pharmacopoeia.
4. Organic Chemistry by I.L. Finar, Vol. II.
5. The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
6. Text book of practical organic chemistry- A.I.Vogel.

IX. Co-CurricularActivities

Mandatory:*(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

1. **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of comprehensive product development programs to meet new product criteria and timing. Acquire skills in the preparation of Drugs, foods and Dairy Products, carry out food testing with the knowledge of testing food adultrationand learn the procedure of synthesis of drugs.

2. **ForStudents**:Studentshallvisitarelatedindustry/chemistrylaboratoryinuniversities/research organizations/private sector facility and observes the preparation of Cosmeceuticals and Pharmaceutical. Write their observations and submit a hand written fieldwork/project workreportnotexceeding10 pages in the given format to the teacher.

   a). MaxmarksforFieldwork/projectworkReport:05.

   b). Suggested Format for Fieldwork/project work**:** *Title page, student details,indexpage,detailsofplacevisited, observations,findings,andacknowledgements.*

   c).Unit tests(IE).

SEMESTER – VII

Skill Enhancement course

Course 20A: Polymer Chemistry

I. Course Learning Outcomes

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

1. Know about history of polymeric materials and their classification

2· Learn about different mechanisms of polymerization and polymerization techniques
3· Evaluate kinetic chain length of polymers based on their mechanism

4· Differentiate between polymers and copolymers

5· Learn about different methods of finding out average molecular weight of polymers

6· Differentiate between glass transition temperature (Tg) and crystalline melting point (Tm)
7· Determine Tg and Tm

8· Know about solid and solution properties of polymers

9· Learn properties and applications of various useful polymers in our daily life.

II. Syllabus:

Unit-1

History of polymeric materials and functionality and its importance [9 hours]

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

Unit-II

Kinetics of Polymerization [9 hours]

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Unit-III

Determination of molecular weight of polymers and crystallinity [9 hours]

(*Mn*,*Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Poly dispersity index. Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Unit-IV

Glass transition temperature (Tg) and Polymer Solution [9 hours]

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymersolutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Unit-V

Properties of Polymers [9 hours]

(Physical, thermal, Flow &Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: poly olefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [poly acetylene, poly aniline, poly(p-phenylene sulphide poly pyrrole, poly thiophene)].

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.

2. G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.

3. F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.

4. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.

5. R.W. Lenz: *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

V. Refernces:

1. Allcock, H.R.; ; Lampe, F. W.; Mark, J. E.(2003),**Contemporary Polymer Chemistry**, Prentice-Hall.

2. Fried, J.R. (2003), **Polymer Science and Technology**, Prentice-Hall.

Course 20A:Polymer Chemistry- Practical Syllabus

VI. Learning Outcomes:

By the end of the course students will be able to

1. Determine the molecular weight of a polymer by viscometric studies

2. Prepare urea formaldehyde polymer

3. Determine the molecular weight by end group analysis

VII. Practical Syllabus

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method

2. Determination of molecular weight by viscometry: Poly vinyl proplylidine (PVP) in water

3. Determination of molecular weight by end group analysis

4. Preparation of urea-formaldehyde resin

5. Precipitation polymerization of acrylonitrile

6. Redox polymerization of acrylamide

VIII. 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 than15 hours on the field techniques/skills of preparation of polymers.

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the preparation steps of polymers and quality polymer formed using various techniques. 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. Unittests(IE).

IX. References:

1. Munk, P.; Aminabhavi, T. M. (2002), **Introduction to Macromolecular Science,** John Wiley &Sons.

2. Sperling, L.H.(2005),**Introduction to Physical Polymer Science**, John Wiley & Sons

SEMESTER – VII

Skill Enhancement Course

Course 20B.Industrial Chemicals and Environment

I. LearningOutcomes:

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

1. Identify the importance of Manufacture of ***Inorganic Chemicals***

2. Acquire knowledge on production, uses, storage and hazards of *Industrial Gases*.

3. Understand the importance of **Environment.**

4. Understanding about water pollution and its effects.

5. Acquire knowledge on **Energy and its effects on Environment**

Syllabus

Unit-I ***9 Hours***

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitricacid, sulphuricacid, causticsoda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum,chrome alum, potassium dichromate and potassium permanganate.

Unit-II **9 Hours**

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine,fluorine,sulphur dioxide and phosgene

IndustrialMetallurgy:

Preparationofmetals(ferrousandnonferrous)andultrapuremetalsforsemiconductortechnology.

Unit-III **9 hours**

Air pollution

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants :types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of

air pollution. Pollution bySO_2, CO_2, CO, NOx, H_2S and other foul smelling gases. Methods of estimation of CO, NOx, Sox and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chloro fluoro carbons and Halogens, removal of sulphur from coal. Control of particulates.

Unit-IV **9hours**

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer,etc.

Unit-V

Energy&Environment **9 hours**

Sources of energy: Coal, petrol and naturalgas.NuclearFusion/Fission,Solarenergy,Hydrogen,geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis:Introduction to biocatalysis :Importance in ―Green Chemistry and Chemical Industry.

II. Suggested Co-Curricular Activities

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

III. Text Books:

1. J.A.Kent:Riegel's *Hand book of Industrial Chemistry*,CBSPublishers,NewDelhi.
2. S.S.Dara: *AText book of Engineering Chemistry,* S.Chand&CompanyLtd.NewDelhi.
3. K.De,*Environmental Chemistry*:NewAge InternationalPvt., Ltd,New Delhi.
4. E.Stocchi: *Industrial Chemistry,*Vol-I,EllisHorwood Ltd.UK.

IV. References Books:

1. E.Stocchi: *Industrial Chemistry,*Vol-I,EllisHorwood Ltd.UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers,New Delhi.
3. J.A.Kent:Riegel's *Hand book of Industrial Chemistry*,CBSPublishers,NewDelhi.
4. S.S.Dara: *A Text book of Engineering Chemistry,* S.Chand&CompanyLtd.NewDelhi.
5. K.De,*Environmental Chemistry*:NewAge InternationalPvt., Ltd,New Delhi.
6. S.M.Khopkar,*Environmental Pollution Analysis*: WileyEasternLtd,NewDelhi.
7. S.E.Manahan,Environmental Chemistry,CRCPress(2005).
8. G.T.Miller,Environmental Science11thedition.Brooks/Cole(2006).
9. A.Mishra,Environmental Studies.Selectiveand ScientificBooks,NewDelhi(2005).

Course 20B: Industrial Chemicals &Environment- PracticalSyllabus

V. LearningOutcomes:

Onsuccessfulcompletion ofthispractical course, studentshall beableto:

1. Perform DeterminationofDO, COD and BOD
2. Learn the procedure for measurementofchloride,sulphateandsalinityofwater
3. Estimationof total alkalinityof water
4. Acquire skills in determination of dissolved gases like O2, CO2,SPMetc.

Practical(Laboratory)Syllabus:

1. Determination of Dissolved Oxygen (DO)in water.
2. Determination of Chemical Oxygen Demand(COD)
3. Determination of Biological Oxygen Demand(BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-},HCO_3^-) using double titration method.
7. Measurement of dissolvedCO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SP Minair samples.
10. Preparation of borax/boricacid.

VI. Lab References:

1. E.Stocchi: *Industrial Chemistry*,Vol-I,EllisHorwoodLtd.UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers,New Delhi.
3. J.A.Kent:Riegel's *Hand book of Industrial Chemistry*,CBSPublishers,NewDelhi.
4. S.S.Dara: *AText book of EngineeringChemistry*,S.Chand&CompanyLtd.NewDelhi.
5. K.De,*Environmental Chemistry*:NewAgeInternationalPvt., Ltd,NewDelhi.
6. S.M.Khopkar,*Environmental Pollution Analysis*: WileyEasternLtd,NewDelhi.

VII. Co-CurricularActivities

Mandatory:*(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

5. **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills in determinationofDO, COD,BOD, CO2,SPM etc. Learn the procedure for measurementofchloride,sulphateandsalinityofwater, total alkalinityof water
6. **ForStudents**:Studentshallvisitarelatedindustry/chemistrylaboratoryinuniversities/research organizations/private sector facility and observes the determinationofDO, COD,BOD, CO2,SPM etc. Write their observations and submit a hand written fieldwork/project workreportnotexceeding10 pages inthegivenformat totheteacher.

a. MaxmarksforFieldwork/projectworkReport:05.

b. Suggested Format for Fieldwork/project work**:** *Title page, student details, indexpage,detailsofplacevisited, observations,findings,andacknowledgements.*

c. Unittests(IE).

VIII - SEMESTER

***Course 21A*: Inorganic Chemistry-II: Metal clusters, Electronic spectra ofComplex compounds and Bio-inorganic chemistry**

I. Course Learning outcomes:

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

1) Understand the study of age compounds of oxygen, phosphorous andsulphur..
2) Explain the various metal clusters and metal π complexes.
3) Describe the reactions of organo metallic compounds and its applications.
4) Understand the reaction mechanism in transition metal complexes.
5) Demonstrate the orgel diagrams and electronic spectra of transition metalcomplexes.
6) Discuss structure and functions of hemoglobin, myoglobin and vitamin B12, photochemical laws.

II. Syllabus

Unit-I:Non-metal cages and metal clusters: **9Hours**

Structure and bonding in phosphorous- oxygen, phosphorous -Sulphur cages; structure and bonding in higher boranes with (special referencetoB$_{12}$ icosahedra). Carboranes, metalloboranes, metallocarboranes. Classification- LNCs and HNCs**,** Isoelectronic and Isolobal relationships, electron counting rules: Wade's and Lauher's rules. M-Mmultiple bonding; preparation ,structure and bonding in dinuclear[Re_2Cl_8]$^{2-}$ ion, trinuclear[Re_3Cl_9], tetranuclear $W_4(OR)_{16}$, hexanuclear[Mo_6Cl_8]$^{4+}$ and [Nb_6Cl_{12}]$^{2-.}$

Unit-II: Organo metallic chemistry of transition metals: 9Hours

Classification and electron counting rules,hapticity, synthesis, structure and bonding of Ferrocene,dibenzene chromium, cycloheptatriene and tropylium complexes of transition metals.Reactions of organo metallic compounds- oxidative addition, reductive elimination,

insertion and elimination. Applications of organo metallic comp ounds-Catalytic hydrogenation, Hydro formylation.

Unit-III: Reaction mechanism of transition metal complexes: 9Hours

Kinetics of octahedral substitution, acid hydrolysis, base hydrolysis - conjugate base (CB) mechanism. Direct and indirect evidences in favour of CB mechanism. Anation reactions.

Reactions without metal-ligand bond cleavage. Factors affecting the substitution reactions in octahedral complexes. Trans effect on substitution reactions in square planar complexes. Mechanism of redox reactions, outer sphere mechanism, cross reactions and Marcus – Hush equation, inner sphere mechanism.

Unit-IV: Term symbols and Electronic spectra: 9Hours

Term symbols and their derivation. Microstates, Hunds rules to predict ground terms and ground states.List of ground energy and higher energy terms from d^1 to d^9 configurations;

Electronic spectra of transition metal complexes: Spectroscopic terms.Selection rules,Slator–Condon parameters, Racah parameters,Term separation energies for d^n configurations. Correlationdiagrams and Orgel diagrams. Tanabe- Sugano diagrams for d^1tod^9 configurations.Calculations of Dq, B and β parameters. Charge transfer spectra.

nit-V:Bio-inorganic chemistry and Magnetic properties of complexes: 9Hours

Bio-inorganic chemistry:

Storage and transport of dioxygen by Hemoglobin and Myoglobin, Chlorophyll, Vitamin B_{12} and its importance.

Magnetic properties of transition metal complexes:

Orbital and spin contribution, spin-orbit coupling and magnetic moments. Types of magnetism, factors affecting on Paramagnetism, Dia, ferro and Antimagnetism.

III. suggested Co- Curricular Activities

1) Training of students by related industrial experts.

2) Assignments, Seminars, discussions, debates 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 Textbooks:

1) Inorganic Chemistry by Huheey.Harper and Row.

2) Concise inorganic chemistry by J.D. Lee ,ELBS.

3) Inorganic chemistry, K.F.Purcell and J.C.Kotz, Holt Saunders international

4) Organo metallic chemistry by R.C.Mehrotra and A.Singh.NewAge International.

5) Advanced Inorganic Chemistry by Cotton and Wilkinson, Wiley Eastern

V. Reference books:

1) Inorganic reaction mechanism by Basolo and Pearson, Wiley Eastern

2) Bioinorganic Chemistry by K.Hussan Reddy

3) Biological Aspects of inorganic chemistry by A.W. Addiso, W.R.Cullen, D.Dorphin and G.J.James. Weliey Interscience.

4) Photo chemistry of coordination compounds by V.Balzani and V. Carassiti. Academic Press.

5) Text book of Coordination chemistry by K.Soma Sekhara Rao and K.N.K.Vani, Kalyani Publishers.

Course 21A: INORGANIC CHEMISTRY PRACTICALS –II

VI. 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 concepts and procedures of preparation of standard solutions, primary and secondary standards.
3) Demonstrate skills in Volumetric and gravimetric determinations.
4) Acquire skills in standardizing and determination of different metal ions.
5) Understand and explain the volumetric analysis based on fundamental concepts learnt in ionic equillibria.

VII. Practical Syllabus:

Quantitative analysis -

Volumetric:

1) Determination of Ferric iron by photochemical reduction
2) Determination of Nickel by EDTA
3) Determination of Calcium and Magnesium in a mixture by EDTA
4) Determination of Ferrocyanide by Ceric sulphate
5) Determination of Copper(II) in presence of iron(III)

Gravimetric:

1) Determination of Zinc as Zinc pyrophosphate
2) Determination of Nickel from a mixture of Copper and Nickel.

VIII. Suggested Co-Curricular Activities

Mandatory:(*Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

1) **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of determination of cations by volumetric and gravimetric determinations.

2) **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 field work/project work report not exceeding10 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).

IX. Reference books:

1) Vogel's text book of quantitative chemical analysis, 5th edition by G.H. Jeffery et al.

VIII - SEMESTER

Course 21B: Organo Metallic Chemistry

I. Learning Outcomes:

By the end of this course, students will be able to

1. Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
2. Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
3. Identify important structural features of the various hapto metal complexes
4. Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst,
5. Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process
6. Understand the importance of organometallic compounds in the synthesis of organic compounds

II. Syllabus:

Unit-I Mono, Di, hapto Complexes [9 hours]

Nomenclature and Classification based on the number of Coordinated Carbons (hapticity) and number of electrons donated by the Ligand. 16 and 18 electron rules.Electron counting covalent and ionic models.□1Complexes : General methods of Preparation –Bonding of Ligand to Metal :α and β Interaction and agostic interaction– Stability and decomposition pathways –□1 Complexes – Tertiary Phosphine – Transition Metal Alkyl and Aryl Complexes of Pt – Ortho-effect – Bonding in Metal – Carbene and Carbyne Complexes. □2 –Complexes: General methods of preparation of Metal –Alkene Complexes – Structure and Bonding in □2 Complexes.

Unit-II Tri, tetra and pentahapto Complexes [9 hours]

□3 - Complexes: Metal-Allyl Complexes – General Preparative Routes – Structure andBonding in □3 Allyl Complexes – Fluxionality. □4 Complexes: Structure and Bonding in

□4 Complexes –Butadiene and Cyclo butadiene Complexes.□5 – Complexes: General methods of Preparation – Bis (□5-cyclopentadienyl) metal complexes (Metallocenes) – Ferrocene: Structure and Bonding –Reactions of Ferrocene – Mechanism of Electroplilic substitution – Friedel Crafts acylation, alkylation, nitration.

Unit-III Hexa, Hepta and Octahapto Complexes [9 hours]

□6Complexes : Metal –Arene Complexes – Dibenzenechromium – Preparation, Structure and Bonding inBis(arene)-Metal Complexes – Reactions. □7 Complexes: Preparation , Structure and Reactions of □7C7H7 Complexes.□ 8 Complexes: C8H8 as a Ligand – Cyclooctatetraene Complexes – Preparation,Structure and Bonding in Uranocene

Unit-IV Catalysis by Organometallic Compounds [9 hours]

General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis

(Catalytic steps, examples and industrial applications), deactivation and regeneration of catalysts, catalyticpoison, promoter.

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)

2. Synthetic gasoline (Fischer Tropsch reaction)

3. Polymerisation of ethene using Ziegler-Natta catalyst

Unit-V Organometallic Reagents in Organic synthesis [9 hours]

Preparation and application of the following in organicsynthesis: 1) Organolithium 2) Organo copper reagents 3) Organoboranes in C-C bondformation 4) Organo silicon reagents: reactions involving β-carbocations and α-carbanions,utility of trimethylsilyl halides, cyanides and triflates.

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 of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

III. Suggested Text Books:

1. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994),**Inorganic Chemistry 2nd Ed.,** Oxford UniversityPress.

2. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010),**Shriver andAtkins Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.

3.Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition,Wiley India.

4.Powell, P.(1988), **Principles of Organometallic Chemistry**, Chapman and Hall.

IV. References:

1. Organometallics-A Concise Introduction, Ch.Eischeinbroich and Salzer-VCH
2.Organotransition Metal Chemistry Fundamental Concepts and Applications, John AkioYamamato,Wiley & Sons.

3. Basic organometallic Chemistry, B.D. Gupta / A. J. Elias

4.Greenwood, N.N.; Earnshaw, A.(1997), **Chemistry of the Elements**, 2nd Edition, Elsevier(Ziegler Natta Catalyst and Equilibria in Grignard Solution)

Course 21B: Organo Metallic Chemistry-Practical Syllabus

V. Learning Outcomes

By the end of the course students will be able to

1. Synthesize inorganic complexes using monodentate ligands
2. Prepare Cis complexes using bi dentate ligands
3. Prepare Trans Complexes using bi dentate ligands
4. Distinguish Cis and Trans compounds

VI. Practical Syllabus:

1. TetraammineCoppe (II) Sulphate monohydrate

2. Potassium tris oxalate Ferrate (III) Tri hydrate

3. Hexaammine Nickel (II) Chloride

4. Preparation of Cis bis (glycenato) Copper (II) monohydrate
5. Preparation of Transbis (glycenato) Copper (II) monohydrate

6. Synthesis of tris (acetyl acetonato) Manganese (III)

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 than15 hours on the field techniques/skills of preparation and identification of complexes

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the synthesis of inorganic metal complexes and analyzing it using IR spectral data. 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. Unittests(IE).

VIII. References:

1. Advanced Practical Chemistry, J. Singh, R.K.P.,Singh, etc. Pragati Edition

2. R.G. Charles, Inorg. Symth. 7 (1963) 183

3. F. Basolo and R.g. Pearson, Mechanisms of Inorganic reactions, 2 nd Edition. Pearson

VIII- SEMESTER

***Course 22A*: Organic Chemistry: Modern Organic synthesis and Natural products**

I. Course Learning outcomes:

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

1) Understand various types of reaction intermediates and the bonding present in various organic compounds.
2) Explain how to protect various functional groups in organic synthesis.
3) Describe the mode of addition reactions by electrophile and nucleophiles.
4) Discuss mechanisms of named reactions and their applications in organic synthesis.
5) Know about the importance of flavones, flavonoids and harmones.

II. Syllabus:

UNIT – I Reactive intermediates, Reactive Species and Protecting groups: 9 hours

Reactive intermediates : Generation, Structure, Stability, Detection and Reactivity of Carbocations,Carbanions, Free radicals, Carbenes, Nitrenes and Arynes.

Reactive Species: Generation and reactivity of Electrophiles, Nucleophiles, Dienophiles, Ylids, Enophiles.

Protecting groups: Protection of carbonyl, Hydroxyl, carboxylic acid and amine groups.

UNIT-II Addition Reactions 9 Hours

Addition to Carbon – Carbon Multiple Bonds: Mechanistic and stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, region and chemo selectivity,orientation and reactivity, Hydrogenation of double and triple bonds, hydrogenation of aromatic rings, Hydroboration.

Addition to Carbon - Hetero Multiple Bonds: Steric course of addition reactions to C=O and C=N, , Knoevenagel, Claisen- Schmidt, Dieckman and Stobbe condensations, Wittig, Grignard, Mannich and Michael reaction.

UNIT-III Molecular Rearrangements 9 Hours

Types of molecular rearrangements, migratory aptitude;

Rearrangements to electron deficient carbon: Wagner-Meerwein, Dienone–Phenol, Arndt-Eistert synthesis;

Rearrangements to electron deficient nitrogen: Beckmann, Hofmann, Schmidt rearrangements;

Rearrangements to electron deficient oxygen: Baeyer-villiger, Benzil-Benzilic acid and Favorskii rearrangements.

UNIT–IV: Steroid harmones 9Hours

Nomenclature, basic skeleton, Diel's hydrocarbon and it's stereochemistry. Isolation, structure determination and synthesis of androsterone, testosterone, oestrone and progesterone.

UNIT–V: Flavonoids and Isoflavonoids: 9 Hours

Nomenclature and general methods of structure determination, Isolation, structure elucidation and synthesis of Kaempferol, Quercetin, Cyanidin, Genestein, Butein and Daidzein. Biosynthesis of flavonoids and Isoflavonoids.

III. Suggested Co- curricular activities

1) Training of students by related industrial experts.
2) Assignments, Seminars, discussions 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 Text books :

1) Advanced Organic Chemistry: Reactions Mechanisms and Structure by JerryMarch, Mc.GrawHill and Kogakush.

2) Organic Chemistry Vol.I(SixthEd)andVol.II(Fifth Ed.) by ILFinar ELBS.

3) Organic Chemistry (fifthEd) by Morrison and Boyd, PHI, India.

4) Organic Chemistry (fifthedition) by Francis A.Carey Tata Mc Graw Hill publishing Company Limited, New Delhi.

5) Chemistry of natural products by S.V.Bhat, B.A.Nagasampangi

V. Reference Books:

1) Reaction Mechanism in Organic Chemistry by Mukherjee Singh.

2) A guide book to mechanism in Organic Chemistry by Peter Sykes, ELBS.

3) Chemistry of Natural products by R.S.Kalsi, Kalyani Publishers.1983.

Course 22A **: ORGANIC CHEMISTRY PRACTICALS –II**

VI. 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 concepts and procedures of handling chemical reagents appropriately.
3) Demonstrate skills to perform reflux, distillation, recrystallisation and vacuum filtration.
4) Calculate theoretical yield and percent yield. .
5) Dispose chemicals in a safe and responsible manner.

VII. Syllabus:

Preparation, recrystallization, and determination of melting point & yield of the following compounds:

1) Aspirin
2) Nerolin
3) Chalcone
4) p-Nitro acetanilide
5) 2,4,6- Tribromoaniline
6) m-Dinitrobenzene
7) Phthalimide
8) Diels-Alder adduct.

VIII. Suggested Co-Curricular Activities

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

1) **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of organic synthesis and recrystallization of the organic compound

2) **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 exceeding10 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).

IX. Reference Books:

1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. J. Thomas, 4^{th}& 6^{th} Ed. (Pearson Education Asia).

2) Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, P.W.G.Smith, A.R. Tatchell, 5 Ed.(Longman Scientific &Technical)

VIII - SEMESTER

Course 22B:Chemistry of Natural Products

I. Course learning Outcomes

By the end of the course students will be able to:

Understand isolation, purification and characterization of simple chemical constituents from the natural source

1. Learn the different types of alkaloids and their chemistry
2. To know the classification of terpenoids, isoprene rule, structures and their natural sources.
3. Learn advanced methods of structural elucidation of compounds of natural origin
4. Understand isolation, purification, chemical constituents from the natural source
5. To know the structure characterization and synthesis of steroids

II. Syllabus:

Unit I: Alkaloids [9 hours]

Introduction, general methods for the elucidation of the structure, breaking into small fragments,determination of structure of fragments.Type of linkage, functional nature of oxygen,zwitter ion method to know number of –OH groups,C=O group,-COOH group –OCH_3 (Ziesel's method).Detection of N atom,Detection of –N-CH_3 group. Herzig–Meyer method to recognize heterogeneous system.Hofmann exhaustive methylation. Emde'sdegradation,Von-Braundegradation,reductivedegradation,Alkali fusion,oxidation,dehydrogenation**.**

Unit - II: Structure and synthesis [9 hours]

1. Phenyl ethyl amine group alkaloids (adrenaline)
2. Piperedine group alkaloids(piperine)
3. Pyridine group alkaloids(coniine)

Unit- III

Terpenoids [9 hours]

Isoprene rule, special isoprene rule, classification.General methods of the determination of structure. Nature of Oxygen, number of alkyl groups (Kuhn-roth method). Unsaturation detection, reduction (NOCl), dehydrogenation , oxidative degradation,ozonolysis, H_2O_2, Baeyer's reagent, NaOX, HNO_3, dehydration–$ZnCl_2$, H_2SO_4 . Catalytic hydrogenation,Grignard reaction, Reformatsky reaction.

Unit-IV Structure and synthesis [9 hours]

Mono terpenoids (acyclic)-Citral–structure and synthesis.Monocyclic mono terpenoids:
α -Terpeniol, Menthol, Limonine –Structure and Synthesis

Unit-V

Steroids [9 hours]

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol (Synthesis not required), Bio Synthesis of Steroids**.** Chemistry and synthesis of oestrone, progesterone, androsterone, testosterone.

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1. Some Modern methods of Organic Synthesis W. Carithers, Cambridge University Press, Cambridge.

2. Organic Chemistry: Stereochemistry and the Chemistry of Natural Products.-I.L. Finar, Pearson Education, Asia

3. Organic Chemistry, Morrison and Boyd, Pearson, 7th Edition

4. Organic Chemistry, Solmons and Fryhle, Willy Student Edition

5. Organic Chemistry a Lab Manual, Piva, Lampman, Engel. Cengage Learning India

V. References:

1.The terpenoids by Simonsen

2) The steroids by Shoppee

3) Chemistry of Carbon compounds by Rodd

Course 22B:Chemistry of Natural Products- Practical Syllabus

VI. Learning outcomes:

By the end of the course students will be able to:

1. Separate the natural products using chromatographic techniques

2. Identify the alkaloids present in extracted natural products

3. Identify the terpenes present in plant extracts

4. Identify the steroids present in plant extracts

5. Identify the phenolic groups present in natural products

VII. Practical Syllabus

1. Separation of natural products using column chromatography

2. Identification of alkaloids in any three plant extracts

3. Identification of terpenes in any three plant extracts

4. Identification of diterpinoids in any three plant extracts

5. Identification of Steroids in any three plant extracts

6. Identification of phenolic groups in three plant extracts

VIII. 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 than15 hours on the field techniques/skills of analyzingorganic compounds using spectroscopic data.

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the separation of natural products obtaining spectral data and analyzing the functional

groups and type of natural product. Write their observations and submit a hand written fieldwork/project work report not exceeding10 pages in the given format

to the teacher.

3. Max. Marks for Fieldwork/project work Report:05.

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

5. Unittests(IE).

IX. References:

1) The terpenoids by Simonsen

2) The steroids by Shoppee

3) Chemistry of Carbon compounds by Rodd

VIII - SEMESTER

***Course 23A*: Physical Chemistry: Quantum and Molecular Spectroscopy**

I. Course Learning outcomes:

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

1) Learn the basic non-relativistic quantum mechanics.
2) Understand the time-dependent and time-independent Schrödinger equation.
3) Describe the principles and theories of rotational, vibrational and vibrational spectroscopy methods.
4) Interpret the molecular spectra and find molecular properties from molecular spectra.

Syllabus:

Unit – I Basic Quantum Chemistry-I- : 9 Hours

Wave equation - interpretation of wave function-properties of wave function-normalization and orthogonalisation, Operators- linear and non-linear- commutators of operators. Postulates of quantum mechanics; setting up of operators to observables; Hermitian operator- Eigen values and Eigen functions of Hermitian operator; Expansion theorems. Eigen functions of commuting operators-significance. Simultaneous measurement of properties and the uncertainty principle.

UNIT-II Basic Quantum Chemistry-II- : 9 Hours

Wave mechanics of simple systems with constant potential energy, particle in one dimensional box- factors influencing color transition- dipole integral, Symmetry arguments in deriving the selection rules, the concept of tunneling- particle in three - dimensional box. Calculations using wave functions of the particle in a box-Orthogonality, measurability of energy, position and momentum, average values and probabilities. Rigid rotor, Wave mechanics of systems with variable potential energy-simple harmonic oscillator- solution of wave equation- selection rules.

UNIT-III Fundamentals of Molecular Spectroscopy-I: 9 Hours

Microwave and IR- Spectroscopy- Rotational spectra of diatomic molecules - Rigid rotor

- Selection rules- Calculations of bond length- Isotopic effect, Second order stark effect

and its applications. Infrared spectra of diatomic molecules- harmonic and anharmonic oscillators - Selection rules- Overtones- Combination bands- Calculation of force constant, anharmonicity constant and zero point energy. Fermi resonance, simultaneous vibrational - rotational spectra ofdiatomic molecules.

UNIT- IV. Fundamentals of Molecular Spectroscopy - II : 9Hours

Raman and Electronic Spectra- Classical and quantum mechanical explanations- Rotational Ramanand Vibrational Raman spectra. Electronic spectra of diatomicmolecules- Vibrational Coarse structure- intensities of spectral lines- Franck-Condon principle- applications, Rotational Fine structure- band headand band shading. Charge transfer spectra.

UNIT- V Introduction to computer programming- FORTRAN 77: 9 Hours

Basic structures and functioning of computer with P.C. as an illustrative example- Main memory- Secondary storage memory- input/output devices- computer languages- operating systems- principles of algorithms-and flow charts-constants and variables- Arithmetic expressions- Arithmetic statements-Replacement statement- IF statement- logical IF and BLOCK IF statements- GOTO statements-subscripted variable and DIMENSION statement. DO statement- Rules for DO statement- Functions and subroutines- Development of FORTRAN statements for simple formulae in chemistry such as Vander Waals equation- pH of a solution- First order rate equation- Cell constant- Electrode potential. Flow charts and computer programs for Program for the calculation of Cell Constant, Specific Conductance and Equivalence. Rate Constant of First order reaction or Beer's law by linear least square method. Hydrogen ion concentration of a strong acid solution/Quadratic equation. Solution for Vander Waals equation or Hydrogen ion concentration of a monoprotic weak acid Standard deviation and Variance of univariant data.

II. 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

III. List of Text books:

1) Fundamentals of Molecular spectroscopy: by C.N. Banwell

2) Molecular spectroscopy: by B.K.Sharma

3) Molecular spectroscopy: by Aruldas

4) Introductory quantum mechanics: by A.K. Chandra

IV. Reference books:

1) Quantum chemistry: by R.K. Prasad

2) Principles of computer programming(FORTRAN 77 IBM PC): by V.Rajaraman

3) Basics of computers for chemists: by P.C. Jurs

Course 23A: **PHYSICAL CHEMISTRY PRACTICALS –II**

V. 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 and apply the concepts of electro chemistry in experiments.
3) Be familiar with electro analytical methods and techniques which study an analyte by measuring the potential (volts) and / or current (amperes) in an electro chemical cell containing the analyte.
4) Learn the procedures of preparation of standard solutions.
5) Acquire skills in operation and calibration of instruments.

VI. Syllabus:

1) Titration of mixture Strong acid and weak acid versus Strong base by conductometry.
2) Titration of Strong acid Vs Strong Base – pH – metry.
3) Titration of mixture of ($NaHCO_3$ + Na_2CO_3) Vs HCl – pH- metry.
4) Titration of Strong acid Vs Strong Base using Quinhydrone electrode.
5) Titration of Fe^{+2}Vs $K_2Cr_2O_7$ – potentiometry
6) Verification of Beer-Lambert's law by Iron- thiocyanate system –colorimetry.
7) Determination of single electrode potential of Cu^{2+}/Cu and estimate the given unknown concentration.

VII. Suggested Co- Curricular Activities

Mandatory:*(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

1. **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of handling the pHmetry, potentiometry and colorimetry. .

2. **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 field work /project work report not exceeding10 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. Reference books:

1. Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. J. Thomas, 4^{th}& 6^{th} Ed. (Pearson Education Asia).

VIII - SEMESTER

Course 23B: Analytical Methods of Analysis

I. Learning Outcomes:

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

1· Perform experiment with accuracy and precision.

2· Develop methods of analysis for different samples independently.
3· Test contaminated water samples.

4· Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer.

5· Learn separation of analytes by chromatography.

6· Apply knowledge of geometrical isomers and keto-enoltautomers to analysis.
7· Determine composition of soil.

8· Estimate macronutrients using Flame photometry.

II. Syllabus:

Unit 1:Qualitative and quantitative aspects of analysis:9h

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression.Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data,and confidence intervals.

Unit 2:Optical methods of analysis 9 h

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selectionRules.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator anddetector) for single and double beam instrument; Transmittance. Absorbance and Beer-Lambert lawBasic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometricalisomers, keto-enoltautomers. Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice ofsource, monochromator, detector, choice of flame and Burner designs). Techniques of atomization andsample introduction; Method of background correction, sources of chemical interferences and theirmethod of removal, Techniques for the quantitative estimation of trace level of metal ions from watersamples.

Unit 3:Thermal methods of analysis: 9 h

Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser.Techniquesfor quantitative estimation of Ca and Mg from their mixture.

Unit 4:Electroanalyticalmethods 9 h

Classification of electro-analytical methods, basic principle of pH metric, potentiometric andconductometric titrations.Techniques used for the determination of equivalence points. Techniques usedfor the determination of pKa values.

Unit5:Separation techniques9 h

Solvent extraction: Classification, principle and efficiency of the technique.Mechanism of extraction: extraction by salvation and chelation, Technique of extraction: batch,continuous and counter current extractions, Qualitative and quantitative aspects of solvent extraction:extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueousmedia.

Chromatography: Classification, principle and efficiency of the technique, Mechanism of separation:adsorption, partition & ion-exchange.

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 of abilities, firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1. Willard, H.H.(1988),**Instrumental Methods of Analysis**, 7th Edition, Wardsworth Publishing Company.

2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.

3. Harris, D. C.(2007),**Quantitative Chemical Analysis**,6th Edition, Freeman.

V. References:

1. Khopkar, S.M. (2008), **Basic Concepts of Analytical Chemistry,** New Age International Publisher.

2. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), **Principles of Instrumental Analysis,**

Thomson Asia Pvt. Ltd.

Course 23B: Analytical Methods of Analysis- Practical Syllabus

VI. Learning Outcomes

By the end of the course students will be able to

1. Separate ions using chromatography
2. Identify the ion by comparing Rf values with the literature
3. Analyze soil parameters
4. Verify Beer Lamberts law
5. Determine the carbonate and bicarbonate using pH

VII. Practical Syllabus

1. Separation of mixtures by paper chromatography and reporting the Rf values of Co^{2+} and $Ni^{2+.}$

2. Separation of mixtures by paper chromatography and reporting the Rf values of Amino acids present in the given mixture

3. To separate a mixture of Ni^{2+}& Fe^{2+} by complexation with DMG and extracting the Ni^{2+} DMG complex in chloroform, and determine its concentration by spectrophotometry

4. Analysis of soil:

(i) Determination of p^H of soil.

(ii) Estimation of calcium and magnesium

(iii) Qualitative detection of nitrate and phosphate

5. Verification of Lambert-Beer's law and determination of concentration of a coloured species ($CuSO_4$, $KMnO_4$)

6. Determination of carbonate- and bicarbonate in a mixture using p^Hmetry

VIII. 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 than15 hours on the field techniques/skills of estimating the quality of soil.

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes various measured parameters of soil analysis. 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.Unittests(IE).

IX. References:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989),**Vogel's Textbook of QuantitativeChemical Analysis**,John Wiley and Sons.

2. Analytical Chemistry by Gary D. Christian 6th Edition John Wiley &Sons Inc New York 1994.

VIII - SEMESTER

Skill Enhancement courses

Course 24A: Pharmaceutical and Medicinal Chemistry

I. Learning Outcomes:

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

1) Know the Terminology in Pharmaceutical chemistry.
2) Describe the classification of Pharmaceutical chemistry
3) Learn the procedure for Synthesis and therapeutic activity of the compounds.
4) Acquire knowledge on Pharmacodynamics and Anesthetics Drugs
5) Gain knowledge on HIV-AIDS and Drugs.

II. Syllabus:

UNIT-I Pharmaceutical chemistry 9 hours

Terminology: Pharmacy, Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics (ADME, Receptors - brief treatment), Metabolites and Anti metabolites. Nomenclature: Chemical name, Generic name and trade names with examples.

UNIT-II Classification of Drugs 9 hours

Classification based on structures and therapeutic activity with one example each, Administration of drugs. Absorption of drugs - factors affecting absorption of drugs,

routes of administration - local, enema, oral and external, parental routes - advantages and disadvantages.

UNIT-III Synthesis and therapeutic activity of the compounds: 9hours

a.Chemo theraputic Drugs : l.Sulpha drugs (Sulpha methoxazole) 2.Antibiotics - β-Lactam Antibiotics, MacrolideAntibiotics, 3. Anti malarial Drugs(chloroquine)

b.Psychotherapeutic Drugs: 1.Anti pyrectics (Paracetamol) 2.Hypnotics, 3.Tranquilizers (Diazepam) 4.Levodopa

UNIT-IV Pharmacodynamics and Anesthetics Drugs: 9hours

1) Antiasthma Drugs (Salbutamol)
2) Antianginals (Glyceryl trinitrate)
3) Diuretics (Furosemide)
4) Anesthetics - general - ether, chloroform, ethyl chloride, halothane, nitrous oxide, local -esters - cocaine, benzococaine.

UNIT-V HIV-AIDS: 9 hours

Immunity - CD-4cells, CD-8cells, Retro virus, Replication in human body, Investigation available, prevention of AIDS, Drugs available - examples with structures: PIS: Indinavir (crixivan), Nelfinavir (Viracept), AZT- Zidovudine.

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 andmaterial.
3) Visits of related Industries/firms, research organizations etc.
4) Invited lectures and presentations on related topics by field/industrial experts.

IV. List of text Books:

1) Synthetic Drugs by O.D.Tyagi & M.Yadav3.Medicinal Chemistry by Ashutoshkar
2) Medicinal Chemistry by P.Parimoo
3) Pharmacology& Pharmacotherapeutics R.S Satoshkar & S.D.Bhandenkar
4) Reference Books:
5) Medicinal Chemistry by Dr. B.V.Ramana
6) Synthetic Drugs by O.D.Tyagi & M.Yadav3.Medicinal Chemistry by Ashutoshkar
7) Medicinal Chemistry by P.Parimoo

V.

1) Pharmacology& Pharmacotherapeutics R.S Satoshkar & S.D.Bhandenkar

2) Medicinal Chemistry by Kadametal P-I & P.II

3) European Pharmacopoeia.

Course 24A. Pharmaceutical and Medicinal Chemistry- Practical Syllabus

Skill Enhancement course

VI. Learning Outcomes:

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

1) Learn the procedure for the synthesis of drugs.
2) Synthesis of Drugs Assisted by Microwave Oven
3) Acquire skills in Drawing structure and Reaction using Chemdraw
4) Know the reactions and mechanisms involved in synthesis of Drugs.

VII. Laboratory course Syllabus

1) Synthesis of Sulphanilamide

2) Synthesis of 7- Hydroxy -4- methyl coumarin

3) Synthesis of Chlorobutanol

4) Synthesis of Tolbutamide 07

5) Assay of Chlorpheniramine Maleate

6) Assay of Benzyl Penicillin 2

7) Synthesis of Aspirin Assisted by Microwave Oven

8) Drawing structure and Reaction using Chemdraw

VIII. List of Reference books:

1) Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
2) Foye's Principles of Medicinal Chemistry.
3) Burger's Medicinal Chemistry, Vol I to IV.
4) Introduction to principles of drug design- Smith and Williams.
5) Remington's Pharmaceutical Sciences.
6) Martindale's extra pharmacopoeia.
7) Organic Chemistry by I.L. Finar, Vol. II.
8) The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
9) Text book of practical organic chemistry- A.I.Vogel.

IX. 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 than15 hours on the field techniques/skills of comprehensive product development programs to meet new product criteria and timing. Acquire skills in the preparation of drugs and pharmaceuticals, learn the procedure of synthesis of drugs with good yield.
2) **For Students**: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the preparation of Cosmeceuticals and Pharmaceutical. Write their observations and submit a hand written fieldwork/project work report notexceeding10 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).

X. Reference books:

1) The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.

2) Text book of practical organic chemistry- A.I.Vogel.

VIII – SEMESTER

Skill Enhancement course

Course-24B. Pesticides and Green Chemistry

I. LearningOutcomes:

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

1. Understand the basic knowledge of pesticides and their classification.
2. Explain the synthetic methods of pesticides.
3. Acquire knowledge about the different types of pesticide formulations and their use.
4. Explain conceptsin green chemistry.
5. State and explain the principles of green chemistry.
6. Identify the need of green chemistry and green synthesis.
7. Think to design and develop materials and processes that reduce the use and generation of hazardous substances in industry.

II. Syllabus

Unit-I Pesticides 9h

Introduction to pesticides, advantages and disadvantages of pesticides, types of pesticides–Insecticides, Fungicides, Herbicides, Weedicides, Rodenticides plant growth regulators, Pheromones and Hormones. Brief discussion with examples, Structure and uses.

Unit-II Pesticides Synthesis 9h

Synthesis and uses of representative pesticides in the following classes: Organochlorines (DDT,Gammexene); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl);Quinones(Chloranil); Anilides (Alachlor andButachlor).

Unit-III PesticideFormulations 9h

Dust and Granules, Wettable powders, seed disinfectant, Surfactants, Emulsifiable concentrates, Aerosols, Sprays, and Controlled ReleaseFormulations.

Unit-IV GreenChemistry 9h

Introduction: Definition of green Chemistry, need of green chemistry, twelve principles of GreenChemistry with their explanations and examples; Green Synthesis-Maximum utilization ofreactantsandreagents(atomeconomy).Selection ofsolvent:Aqueousphasereactions,Reactionsin ionic liquids, Solid supported synthesis, Solvent free reactions (solid phase reactions), andGreencatalysts:Phasetransfer catalysts(PTC) and Biocatalysts.

Unit-V **Green Synthesis** 9h

Green Synthesis of the following compounds: Styrene, Adipic Acid,Catechol, BHT, Methyl Methacrylate, Urethane,4-amino dipheny lamine, benzyl bromide, Acetaldehyde, Furfural, Ibuprofen,Paracetamol,Citral.

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 of related Industries/firms, research organizations etc.
4. Invited lectures and presentations on related topics byfield/industrial experts.

IV. TEXT BOOKS

1. Industrial chemistry byB.K.Sharma. GoelPublishingHouse,Meerut.
2. E.Stocchi:Industrial Chemistry,Vol-I,EllisHorwoodLtd.UK.
3. Chemistry of pesticidesbyN.K.Roy
4. R.Cremlyn:Pesticides,JohnWiley.
5. V.K.Ahluwalia&M.R.Kidwai:NewTrendsinGreenChemistry,AnamalayaPublishers(2005).

6. P.T. Anastes& J.K. Warmer: Oxford Green Chemistry- Theory and Practical, UniversityPress(1998).

7. A.S.Matlack: IntroductiontoGreenChemistry,MarcelDeckkar(2001).

V. References Books:

1. Fundamentals of industrial chemistry–pharmaceuticals, polymers and business by JohnA.Tyrell.

2. Riegel's Hand book of Industrial Chemistry ninth edition Edited byJamesA.Kent.

3. E.Stocchi:Industrial Chemistry,Vol-I,EllisHorwoodLtd.UK.

4. Chemistry of pesticides byN.K.Roy

5. R.Cremlyn:Pesticides,JohnWiley.

6. PesticidesFormulations–VanWade.Velkenburg,1973.

7. PesticidesSynthesis–Mavy,Kohn,Menn,1979.

8. Kirchoff,M.&Ryan,M.A.Greenerapproachestoundergraduatechemistryexperiment.AmericanChemical Society, Washington DC (2002).

Course-24B: Pesticides and Green Chemistry-Practical Syllabus:

Skill Enhancement course

VI. Laboratory-Skills 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. Acquire skills in Microwave assisted organic synthesis.
4. Perform some applications of green synthesis.

VI. Practical Laboratory)Syllabus

The list of suggestive experiments is given below. However, depending upon available resources, any three experiments may be conducted)

1. Benzoin condensation using Thiamine Hydrochloride as acatalyst(instead of cyanide).
2. Formation of Chalcones–A Greener Alternative.
3. Preparation of Salicylic Acid(Aspirin)by Microwave Assisted Method.
4. Green Synthetic Process for Acetanilide.
5. Green Synthetic Process for Dibenzal Propanone.
6. Green Synthetic Process for trans esterification of vegetable oil to crude bio-diesel.

VII. Recommended Books / References:

1. Anastas,P.T&Warner,J.C.GreenChemistry:TheoryandPractice,OxfordUniversityPress(1998).
2. Kirchoff,M.&Ryan,M.A.Greenerapproachestoundergraduatechemistryexperiment.American Chemical Society, Washington DC (2002).

3. Ryan,M.A.IntroductiontoGreenChemistry,Tinnesand;(Ed),AmericanChemicalSociety, Washington DC (2002).

4. Sharma,R.K.;Sidhwani,I.T.andChaudhari,M.K.I.K.GreenChemistryExperiment:Amonograph,International Publishing ISBN 978-93-81141-55-7 (2013).

5. Cann,M.C.andConnelly,M.E.RealworldcasesinGreenChemistry,AmericanChemicalSociety (2008). UGC DOCUMENT ON LOCFCHEMISTRY 83

6. Cann,M.C.andThomas,P.RealworldcasesinGreenChemistry,AmericanChemicalSociety

(2008).

7. Lancaster,M.GreenChemistry:AnIntroductoryTextRSCPublishing,SecondEdition,2010.

8. Pavia,D.L.,Lampman,G.M.,Kriz,G.S.&Engel,R.G.IntroductiontoOrganicLaboratoryTechniques: AMicroscale and Macro Scale Approach, W. B. Saunders, 1995.

IX. Co-CurricularActivities

a. **Mandatory:***(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05*):

1. **For Teacher**: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of comprehensive product development programs to meet new product criteria and timing. Acquire skills in the preparation of Cosmeceuticals and Pharmaceutical drugs, Carry out perfume testing with the knowledge of perfumes and learn the procedure of synthesis of drugs.

2. **ForStudents**:Studentshallvisitarelatedindustry/chemistrylaboratoryinuniversities/research organizations/private sector facility and observes the preparation of Cosmeceuticals and Pharmaceutical. Write their observations and submit a hand written fieldwork/project workreportnotexceeding10 pages in the given format to the teacher.

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

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

c) Unit tests(IE).

VIII - SEMESTER

Skill Enhancement course

Course-25A:Corrosion and Its Prevention

I. Learning Outcomes:

1. This course will create awareness of corrosion and its control process

2. It focuses on protective metallic coatings for prevention of corrosion

3. It focuses on protective coatings of materials.

4. It covers about the insulating materials in electric industries and also aware about semiconductors.

II. Syllabus:

Unit-I: Corrosion 9h

Introduction - Economic aspects of corrosion - Dry or Chemical Corrosion - Wet or electrochemical corrosion - Mechanism of Electrochemical Corrosion. Galvanic Corrosion - Concentration Cell Corrosion - Differential aeration corrosion – Pitting Corrosion-Underground or soil corrosion-Passivity.

Unit-II: CorrosionandItsControl 9h

Factors Influencing Corrosion - Microbiological Corrosion, Atmospheric corrosion – Corrosion Control-Proper designing –Using pure metal-Using metal alloys.

Chemical conversion – Coating - Phosphating - Chromising - Treatment of metal surfaces hot dipping-Use of inhibitors.

Unit-III: ProtectiveCoatings 9h

Introduction-Metallic Coatings-Various methods of cleaning articles before electrod eposition

– Electroplate and -Electroplating methods.

Pre-treatment of the surface–Metallic Coatings-Hot Dipping-Cementation or Impregnated Coatings-Sprayed Metal Coatings-Cladding–Vapour Deposition.

Unit-IV Paints **9h**

Paints-ingredients and their functions, required properties of aPaint-Paint Constituents and their Functions-Manufacture of Paint.

Types of Pigments-Characteristics of pigment-Oils-Uses in Paint Emulsion Paints–Special Paints-Paint Remover Varnishes.

Unit-V: Insulators and Semiconductor **9h**

Electrical Insulating Materials-Dielectric properties-Requirements of an Electrical Insulating Material-Classification of insulating material-Electrical Rigid Insulations.

Semiconductors-Introduction-Classification–Degenerate semiconductors–Superconductors.

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 of related Industries/firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Text Books

1. M.G.Fontana:Corrosion Engineering, McGrawHillInternationalBookCo. London.
2. L.L. Shreir: Corrosion, Vol I and Vol II, Newness Butterworths, EdwardArnoldLtd, London.
3. J.C.Scully:Fundamental of Corrosion,PergamonPressInc.NewYork, USA.

V. References Books:

1. M.G.Fontana:Corrosion Engineering,McGraw Hill InternationalBookCo. London.
2. L.L. Shreir: Corrosion, Vol I and Vol II, Newness Butterworths, EdwardArnoldLtd, London.
3. J.C.Scully:Fundamental of Corrosion,PergamonPressInc.NewYork, USA.
4. V.S.Sastry:Corrosion Inhibitors,Principles&Applications,JohnWiley&Sons.
5. C.C.Nathan:Corrosion Inhibitors,NACE,Houston,Texas.
6. Corrosion-Causes and Prevention:Speller.F. N.
7. Material Science mini refresher byH.S.Bawa, TatapublisherIndia.

Course 25A:Corrosion and its Prevention-Practical Syllabus:

Skill Enhancement course

VI. LearningOutcomes:

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

1. Chalk out a plan to decrease the rate of corrosion.
2. Preparation of pigment.
3. To study about the Rate of corrosion with respect to Aluminium and Iron plates
4. To determine the effect of Temperature on rate of corrosion

Practical(Laboratory)Syllabus:

5. Electroless metallic coatings on ceramic and plastic material.
6. Preparation of pigment (zincoxide)
7. To determine the rate of corrosionon different metallic plates (Iron,Aluminium) in various Concentrations of HCl.
8. To determine the effect of temperature on rate of corrosion in acidic medium.
9. To determine the rate of corrosion on a metallic plate in acidic medium.
10. To determine the rate of corrosion on an Aluminium plate in basic medium.

VII. LabReferences:

1. Analytical ChemistrybyGaryD.Christian 6th edition Wileypublication.
2. Senior Practical Physical Chemistry, B.D.Khosla, V.C.Garg, Adarsh Gulati, RChandandCo.
3. Applied Chemistry Theory and Practice, O.P.Virani, A.K.Nebula. NewAge InternationalPublishers,2nd Edition.
4. S.W.Rajbhoj andT.K.Chondhekar,SystematicExperimentalPhysical Chemistry,Anjali Publication,Second Edition 2000.

5. SunitaRattan,ExperimentsinAppliedChemistry,S.K.Kataria&Sons,Secondedition, 2008

6. Khosla,B.D.;Garg,V.C.&Gulati,A.SeniorPracticalPhysicalChemistry,R.C hand &Co.:NewDelhi (2011).

7. UGC practical manual for experimental analysis.

VIII. Cocurricular Activities:

a) Mandatory:*(Lab/fieldtrainingofstudentsbyteacher:(lab:10+fields:05*):

1. ForTeacher: Training of students byt he teacher in laboratory and field for not less than15hours on the field techniques/skills of corrosion formation observations in nature.

2. For Students: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes corrosion process and its prevention. Write their observations and submit a

hand written fieldwork/project work report notexceeding10 pages in the given format to the teacher. And also observe the semiconductors, insulators used in industry.

a.Max marks for Fieldwork/projectworkReport:05.

b. SuggestedFormatforFieldwork/projectwork**:** *Title page, student details, index page,details of place visited, observations, findings and acknowledgements.*

C. Unit tests(IE).

VIII - SEMESTER

Skill Enhancement course

Course 25B: Material & Energy Balances and Utilities in Chemical Industry

I. Learning Outcomes:

At the end of the course student will be able to

1. Describe the distinction between Atomic weight, Molecular weight and Equivalent Weight.
2. Write down the flow diagrams for chemical engineering operations.CO3
3. Describe the capacities of gases and gaseous mixtures.
4. Write down water treatment procedures for industrial use.
5. Describe the types of boilers.
6. Demonstrate knowledge acquired in steam generation.
7. Write down compressors and blowers.
8. Classify pumps based on their function.

II. Syllabus:

Unit-I **9h**

Dimensions and units: Basic Chemical Calculations -Atomic weight, molecular weight, equivalent weight, Mole, composition of(i) Liquid mixtures and (ii)gaseous mixtures. Ideal gas law, vapor pressure, Humidity and Saturation.

Unit-II **9h**

Material Balance without Chemical Reactions: Flow diagram for material balance, simple material balance with or without recycle or by-pass for chemical engineering operations such as distillation, absorption, crystallization, evaporation and extraction.

Material Balance involving chemical reactions: concept of limiting reactant, conversion, yield, selectivity and liquid phase reaction, gas phase reaction with o rwith out recycleor by pass.

Unit-III **9h**

Energy Balance: Heat capacity of pure gases and gaseous mixtures at constant pressures, sensible heat changes in liquids, Enthalpy changes during phase transformation: Enthalpy of

fusion, Enthalpy of vaporization,

Enthalpy of condensation, Enthalpy of sublimation, Hess's law of constant, Heat Summation and its applications

Unit-IV **9h**

Utilities in Chemical Industry

a) **Boilers**:Types of boilers and their functioning

b) **Water**: Specifications of industrial use,various water treatments.

c) **Steam**:Generation and use.

d) **Air**:Specification of industrial use,process ingofair

Unit-V **9h**

Fluid flow and Pumps

Fluid flow: Fans, blowers, compressors, vacuum pump, ejectors.

Pumps: Reciprocating pumps, Gear pumps, centrifugal pumps**.**

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 of related Industries/firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

IV. Text Books:

1. E.Stocchi:*IndustrialChemistry*,Vol-I,EllisHorwoodLtd.UK
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers,NewDelhi.
3. P.C.Jain,M.Jain:*EngineeringChemistry*,DhanpatRai&Sons,Delhi.
4. B.K.Sharma:*EngineeringChemistry*,GoelPublishingHouse,Meerut

V. ReferenceBooks:

1. B.I. Bhatt and S.M. Vora: *Stoichiometry*, Tata McGraw-Hill publishing Company Ltd,NewDelhi.
2. E.Stocchi:*IndustrialChemistry*,Vol-I,EllisHorwoodLtd.UK
3. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers,NewDelhi.
4. J.A.Kent:Riegel's*HandbookofIndustrialChemistry*,CBSPublishers,NewDelhi.
5. P.C.Jain,M.Jain:*EngineeringChemistry*,DhanpatRai&Sons,Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications,NewDelhi.
7. B.K.Sharma:*EngineeringChemistry*,GoelPublishingHouse,Meerut
8. S.C.Bhatia: *ChemicalProcessIndustries*,Vol.I&II,CBSPublishers,NewDelhi.
9. W. L. McCabe and J. C.Smith: *Unit Operations in Chemical Engineering*, Mc-Graw HillBook Company,NewYork.
10. O. P. Vermani, A. K. Narula: *Industrial Chemistry*, GalgotiaPublicationsPvt. Ltd., NewDelhi.

Course 25B: Material & Energy Balances and Utilities in Chemical Industry-Practical Syllabus

Skill Enhancement course

VI. Learning Outcomes

At the end of the course student will be able to

1.Carry out the Quantitative analysis of calcium in lime stone.
2.Determine the hardness of given water sample using EDTA.
3.DetermineCODand BODofagiven watersample.

4.FindoutthePercentageofavailablechlorinepresentin thebleachingpowder.

VII. PracticalSyllabus

1. Quantitative analysis of calcium in limestone by complexometric titration.
2. Hardness of water by EDTA titration.
3. Determination of Chemical Oxygen Demand(COD)
4. Determination of Biological Oxygen Demand(BOD)
5. Percentage of available chlorine in bleaching powder

VIII. Reference Books:

1. 4.J.A.Kent:Riegel's*HandbookofIndustrialChemistry*,CBSPublishers,NewDelhi.
2. 5.P.C.Jain,M.Jain:*EngineeringChemistry*,DhanpatRai&Sons,Delhi.
3. 6.R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications,NewDelhi.
4. 7.B.K.Sharma:*EngineeringChemistry*,GoelPublishingHouse,Meerut
5. 8.S.C.Bhatia: *ChemicalProcessIndustries*,Vol.I&II,CBSPublishers,NewDelhi.

IX. Co-CurricularActivities:

a). Mandatory:

1. For Teacher: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of detection of N, S and halogens using thegreen procedure, preparation of TLC plates, detection of organic compounds using $R_f$valuesinTLC/paperchromatography,loadingofcolumn,selectionofsolvents ystem for column chromatography, separation of amino acids and dye mixture using chromatographic techniques.

2. **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 workreportnotexceeding10 pages in the given format to the teacher.

   a. Max marks for Field work/projectworkReport:05.

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

   c. Unit tests(IE).