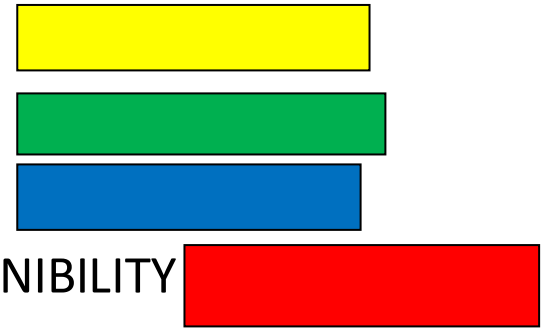
CRITERIA 1.1.3

Different UG And PG Programme, Sample of Courses With Highlight On Ethics / Gender / Human Values / Environment And Sustainability Aspects Is Presented.

Programme: B.Sc Chemistry

1. ETHICS
2. GENDER
3. HUMAN VALUES
4. ENVIRONMENT AND SUSTAINIBILITY



CURRICULUM
FOR
UNDERGRADUATE COURSES UNDER CHOICE BASED CREDIT SYSTEM

B.Sc. (HONOURS IN CHEMISTRY)

DEPARTMENT OF CHEMISTRY

NETAJI SUBHAS UNIVERSITY, JAMSHEDPUR

With effective from academic session 2018

M. N. Mishra

Head
Department of Chemistry
Netaji Subhas University

NETAJI SUBHAS UNIVERSITY Jamshedpur

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand

COURSE HAVING FOCUS ON PROFESSIONAL ETHICS (PE), GENDER (GE), HUMAN VALUES (HV), ENVIRONMENT AND SUSTAINABILITY(ES) in B.Sc. (H) Chemistry

Semester	Course Code	Name of Course	PE	G	HV	ES
I	BSCCHE-101	INORGANIC CHEMISTRY-1	✓			✓
	BSCCHE-102	PHYSICAL CHEMISTRY -1	✓			
	AECC-1	ENGLISH COMMUNICATION			✓	
II	BSCCHE-201	ORGANIC CHEMISTRY -1	✓			
	BSCCHE-202	PHYSICAL CHEMISTRY -2	✓			
	AECC-2	ENVIRONMENTAL SCIENCE	✓		✓	✓
III	BSCCHE-301	INORGANIC CHEMISTRY-2	✓			
	BSCCHE-302	ORGANIC CHEMISTRY -2	✓			
	BSCCHE-303	PHYSICAL CHEMISTRY -3	✓			
	SEC-1	IT SKILLS FOR CHEMISTS	✓		✓	
IV	BSCCHE-401	INORGANIC CHEMISTRY-3	✓			
	BSCCHE-402	ORGANIC CHEMISTRY -3	✓			
	BSCCHE-403	PHYSICAL CHEMISTRY -4	✓			
	SEC-2	FUEL CHEMISTRY	✓			✓
V	BSCCHE-501	ORGANIC CHEMISTRY -4	✓			
	BSCCHE-502	PHYSICAL CHEMISTRY -5	✓			
	DSE-1	ANALYTICAL METHODS IN CHEMISTRY	✓			✓
	DSE-2	POLYMER CHEMISTRY	✓			
VI	BSCCHE-601	INORGANIC CHEMISTRY-4	✓			
	BSCCHE-602	ORGANIC CHEMISTRY -5	✓			
	DSE-3	BIO-INORGANIC CHEMISTRY	✓			
	DSE-4	BIO-ORGANIC CHEMISTRY	✓			

Head
Department of Chemistry
Netaji Subhas University

NETAJI SUBHAS UNIVERSITY Jamshedpur

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand

NETAJI SUBHAS UNIVERSITY, JAMSHEDPUR

DEPARTMENT OF CHEMISTRY
PROGRAMME NAME: B.Sc. CHEMISTRY (H)
CO, PO & PSO

VISION: The vision of the Department of Chemistry is to excel our status as an outstanding teaching and research institution.

MISSION:The mission of the Department of Chemistry is to provide high valued academic environment and to perform cutting edge research in versatile arenas of chemical sciences. To bring up advanced research programs those enhance knowledge through discovery and development.

To contribute actively the scientific community, and to engage itself with critical global needs for welfare of humanity. The department of chemistry is devoted to the development of students.

NETAJI SUBHAS UNIVERSITY Jamshedpur

Department of Chemistry	After successful completion of three year degree program in Chemistry a student should be capable to;
Programme Outcomes	PO-1. Demonstrate, solve and an understanding of major concepts in all field of chemistry. PO-2. Solve the question and also judge methodically, independently and draw a logical conclusion. PO-3. Employ critical thinking and the scientific knowledge to design, execute, record and analyze the results of chemical reactions. PO-4. Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community. PO-5. Find out the green route for chemical reaction for sustainable improvement. PO-6. To inculcate the scientific temperament in the students and outside the scientific community. PO-7. Use modern method, various apparatus and chemical softwares.

Programme Specific Outcomes	PSO-1. Gain the knowledge of Chemistry through theory and practical experiments. PSO-2. To explain nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions. PSO-3. Identify chemical formulae and resolve numerical problems. PSO-4. To understand the basic principles of Organic, Inorganic, Physical and Analytical Chemistry and its applications through Various laboratory experiments. PSO-5. Use modern chemical tools, Models, Chem-draw, Charts and apparatus. PSO-6. Understand good laboratory practices and safety. PSO-7. Develop research oriented skills and thinking. PSO-8. Aware and good command on handling the sophisticated instruments/apparatus/equipments.

Course Outcomes B. Sc Chemistry

Semester- I

Course	Outcomes After completion of these courses students should be able to:
BSCCHE-101 INORGANIC CHEMISTRY-1	CO-1. Gather an in-depth knowledge about atomic structure. CO-2. Understand the periodicity of the elements. CO-3. Understand the concepts of a redox reaction.
BSCCHE-102 PHYSICAL CHEMISTRY -1	CO-1. Gather an in-depth knowledge about Gaseous state, Liquid state and Solid state CO-2. Understand the Ionic equilibria. CO-3. Understand the Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis. CO-4. Understand the Henderson equation and its applications and Theory of acid–base indicators.

SEMESTER - II	
BSCCHE-201 ORGANIC CHEMISTRY I	CO-1. Basics of Organic Chemistry CO-2. Stereochemistry: CO-3. Carbon-Carbon sigma bonds CO-4. Carbon-Carbon pi bonds: CO-5. Cycloalkanes and Conformational Analysis CO-6. Aromatic Hydrocarbons
BSCCHE-202 PHYSICAL CHEMISTRY -2	CO-1. Chemical Thermodynamics CO-2. Systems of Variable Composition CO-3. Criteria of thermodynamic equilibrium, degree of advancement of reaction CO-4. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase CO-5. Solutions and Colligative Properties CO-6. Raoult's and Henry's Laws and their applications
SEMESTER - III	
BSCCHE-301 INORGANIC CHEMISTRY -2	CO-1. General Principles of Metallurgy CO-2. Acids and Bases CO-3. Chemistry of s and p Block Elements CO-4. Allotropy and catenation CO-5. Occurrence and uses, rationalization of inertness of noble gases, Clathrates CO-6. silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates
BSCCHE-302 ORGANIC CHEMISTRY -2	CO-1. Chemistry of Halogenated Hydrocarbons CO-2. Alcohols, Phenols, Ethers and Epoxides CO-3. Carbonyl Compounds CO-4. Carboxylic Acids and their Derivatives CO-5. Claisen condensation, Dieckmann and Reformatsky reactions CO-6. Sulphur containing compounds

BSCCHE-303 PHYSICAL CHEMISTRY -3	CO-1. Phase Equilibria CO-2. Chemical Kinetics CO-3. Catalysis: CO-4. Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces CO-5. Enzyme catalysi CO-6. Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state
SEC-1 IT SKILLS FOR CHEMISTS	CO-1. Basic Computer Concept CO-2. Numbers Systems and Logic Gates CO-3. Computer Software. CO-4. Operating system-Windows CO-5. Microsoft Power Point

SEMESTER - IV	
BSCCHE-401 INORGANIC CHEMISTRY-3	CO-1. Coordination Chemistry CO-2. Crystal field theory CO-3. Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory CO-4. Chelate effect, polynuclear complexes, Labile and inert complexes CO-5. Transition Elements CO-6. Metal ions present in biological systems
BSCCHE-402 ORGANIC CHEMISTRY -3	CO-1. Nitrogen Containing Functional Groups CO-2. Polynuclear Hydrocarbons CO-3. Heterocyclic Compounds CO-4. Alkaloids CO-5. Terpenes
BSCCHE-403 PHYSICAL CHEMISTRY -4	CO-1. Arrhenius theory of electrolytic dissociation. CO-2. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes CO-3. Kohlrausch law of independent migration of ions CO-4. Debye-Hückel-Onsager equation CO-5. Electrochemistry CO-6. Electrical & Magnetic Properties of Atoms and Molecules
SEC-2 FUEL CHEMISTRY	CO-1. Review of energy sources (renewable and non-renewable) CO-2. Classification of fuels and their calorific value. Coal CO-3. Coal liquefaction and Solvent Refining CO-4. Petroleum and Petrochemical Industry CO-5. Classification of lubricants, lubricating oils

SEMESTER - V	
BSCCHE-501 ORGANIC CHEMISTRY -4	CO-1. Nucleic Acids CO-2. Amino Acids, Peptides and Proteins CO-3. Enzymes CO-4. Lipids CO-5. Concept of Energy in Biosystems CO-6. Pharmaceutical Compounds: Structure and Importance
BSCCHE-502 PHYSICAL CHEMISTRY -5	CO-1. Quantum Chemistry CO-2. Schrödinger equation and its application to free particle and "particle-in-a-box" CO-3. Covalent bonding, valence bond and molecular orbital approaches CO-4. Molecular Spectroscopy CO-5. Photochemistry CO-6. Lambert-Beer's law and its limitations
DSE-1 ANALYTICAL METHODS IN CHEMISTRY	CO-1. Qualitative and quantitative aspects of analysis CO-2. Optical methods of analysis CO-3. Thermal methods of analysis CO-4. Electroanalytical methods CO-5. Separation techniques CO-6. NMR, . Chiral chromatographic techniques using chiral columns (GC and HPLC).
DSE-2 POLYMER CHEMISTRY	CO-1. Introduction and history of polymeric materials CO-2. Functionality and its importance CO-3. Kinetics of Polymerization CO-4. Crystallization and crystallinity CO-5. Polymer Solution CO-6. Brief introduction to preparation, structure, properties and application of the polymers

SEMESTER - VI	
BSCCHE-601 INORGANIC CHEMISTRY-4	CO-1. Theoretical Principles in Qualitative Analysis CO-2. Basic principles involved in analysis of cations and anions and solubility products, common ion effect CO-3. Organometallic Compounds CO-4. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls CO-5. Ferrocene: Preparation and reactions CO-6. Reaction Kinetics and Mechanism
BSCCHE-602 ORGANIC CHEMISTRY -5	CO-1. Undestanding Organic Spectroscopy CO-2. NMR Spectroscopy CO-3. Carbohydrates CO-4. Dyes CO-5. Polymers CO-6. Fabrics – natural and synthetic
DSE-3 BIO-INORGANIC CHEMISTRY	CO-1.Understanding Bio-Inorganic Chemistry CO-2. Essential and trace elementsin in biological processes CO-3. Essential Bulk Elements CO-4. 3.Metallomorphyrins CO-5. Haemoglobin and myoglobin functions and co-operativity, structures of haemoglobin and myoglobin CO-6. Nitrogenase : Biological Nitrogen fixation. CO-7. Metals in medicines
DSE-4 BIO-ORGANIC CHEMISTRY	CO-1. Understanding Bio-Organic Chemistry CO-2. 1.Enzymes CO-3. Mechanism of enzyme action CO-4. Bio-technological application of enzyme CO-5. Clinical uses of enzymes CO-6. Co-enzymes

COURSES STRUCTURE OF STUDY FOR UNDERGRADUATE **'B.Sc. Hons'** PROGRAMME

Semester	Paper Name	Credit	I.M.	P.M.	E.M.	Total
I	INORGANIC CHEMISTRY-1	6	20	30	50	100
	PHYSICAL CHEMISTRY -1	6	20	30	50	100
	ANIMAL DIVERSITY	6	20	30	50	100
	ENGLISH COMMUNICATION	2			50	50
	TOTAL	**20**				**350**
II	ORGANIC CHEMISTRY -1	6	20	30	50	100
	PHYSICAL CHEMISTRY -2	6	20	30	50	100
	ANIMAL CELL BIOTECHNOLOGY	6	20	30	50	100
	ENVIRONMENTAL SCIENCE	2			50	50
	TOTAL	**20**				**350**
III	INORGANIC CHEMISTRY-2	6	20	30	50	100
	ORGANIC CHEMISTRY -2	6	20	30	50	100
	PHYSICAL CHEMISTRY -3	6	20	30	50	100
	AQUATIC BIOLOGY	6	20	30	50	100
	IT SKILLS FOR CHEMISTS	2				50
	TOTAL	**26**				**450**
IV	INORGANIC CHEMISTRY-3	6	20	30	50	100
	ORGANIC CHEMISTRY -3	6	20	30	50	100
	PHYSICAL CHEMISTRY -4	6	20	30	50	100
	ENVIRONMENT AND PUBLIC HEALTH	6	20	30	50	100
	FUEL CHEMISTRY	2				50
	TOTAL	**26**				**450**
V	ORGANIC CHEMISTRY -4	6	20	30	50	100
	PHYSICAL CHEMISTRY -5	6	20	30	50	100
	ANALYTICAL METHODS IN CHEMISTRY	6	20	30	50	100
	POLYMER CHEMISTRY	6	20	30	50	100
	TOTAL	**24**				**400**
VI	INORGANIC CHEMISTRY-4	6	20	30	50	100
	ORGANIC CHEMISTRY -5	6	20	30	50	100
	BIO-INORGANIC CHEMISTRY	6	20	30	50	100
	BIO-ORGANIC CHEMISTRY	6	20	30	50	100
	TOTAL	**24**				**400**

* I. M. Internal Marks P. M. Practical Marks E. M.External Marks T. M. Total Marks

SEMESTER I

I. ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

II. GENERIC ELECTIVE (GE 1)

ENGLISH COMMUNICATION

All Four Papers (One paper to be studied in each semester) of any One Subject to be opted other than the Honours Subject. Refer Content from the Syllabus of Opted Generic Elective Subject.

III. BSCCHE-101:

INORGANIC CHEMISTRY-I

Course Objectives:

To provide students with the knowledge of inorganic chemistry

- Gather an in-depth knowledge about atomic structure.
- Understand the periodicity of the elements
- Redox equations, Standard Electrode Potential and its application to inorganic reactions.

I. Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

II. Periodicity of Elements:

s, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

III. Chemical Bonding:

(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(iii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions.
Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

IV. Oxidation-Reduction:

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.

2.Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, ford,

3.Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.

4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

CHEMISTRY PRACTICAL LAB:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Gather an in-depth knowledge about atomic structure.

CO-2. Understand the periodicity of the elements.

CO-3. Understand the concepts of a redox reaction.

INORGANIC CHEMISTRY-1							
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	3	2	2	1	3	3
CO-2	2	2	2	1	2	2	2
CO-3	3	3	2	2	1	3	3
CO-Average	2.67	2.67	2	1.67	1.33	2.67	2.67

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

IV. BSCCHE-102:

PHYSICAL CHEMISTRY I

Course Objectives:

To provide students with the knowledge of physical chemistry

- Gather an in-depth knowledge about Gaseous state, Liquid state and Solid state
- Ionic equilibria.
- Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis.
- Henderson equation and its applications etc.

I. Gaseous state:

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their
Temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.
Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

II. Liquid state:

Qualitative treatment of the structure of the liquid state; Radial distribution function; 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. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

III. Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

IV. Ionic equilibria:

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, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Reference Books:

1.Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).

2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).

3.Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

CHEMISTRY PRACTICAL LAB

1. Surface tension measurements.
   a. Determine the surface tension by (i) drop number (ii) drop weight method.
   b. Study the variation of surface tension of detergent solutions with concentration.
2. Viscosity measurement using Ostwald's viscometer.
   a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
   b. Study the variation of viscosity of sucrose solution with the concentration of solute.
3. Indexing of a given powder diffraction pattern of a cubic crystalline system.
4. pH metry
   a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
   b. Preparation of buffer solutions of different pH
      i. Sodium acetate-acetic acid
      ii. Ammonium chloride-ammonium hydroxide
   c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
   d. Determination of dissociation constant of a weak acid.

Any other experiment carried out in the class.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Gather an in-depth knowledge about Gaseous state, Liquid state and Solid state

CO-2. Understand the Ionic equilibria.

CO-3. Understand the Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis.

CO-4. Understand the Henderson equation and its applications and Theory of acid–base indicators.

PHYSICAL CHEMISTRY -1							
	PO-1	**PO- 2**	**PO- 3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**3**	**3**	**2**	**2**	**2**	**2**	**2**
CO-2	**3**	**3**	**3**	**3**	**1**	**1**	**1**
CO-3	**2**	**1**	**2**	**3**	**2**	**2**	**3**
CO-4	**3**	**3**	**1**	**1**	**1**	**1**	**1**
CO-Average	**2.75**	**2.5**	**2**	**2.25**	**1.5**	**1.5**	**1.75**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

---

SEMESTER II

I. ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

(AECC – ENVIRONMENTAL SCIENCE)

II. GENERIC ELECTIVE (GE 2):

III. BSCCHE-201:

ORGANIC CHEMISTRY I

Course Objectives:

To provide students with the knowledge of organic chemistry

- Basics of Organic Chemistry
- Stereochemistry:
- Carbon-Carbon sigma bonds
- Carbon-Carbon pi bonds:
- Cycloalkanes and Conformational Analysis
- Aromatic Hydrocarbons

I. Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. *Electronic Displacements:* Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

II. Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

III. Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

C. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

IV. Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),

4. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

5 .Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994. 6.Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

CHEMISTRY PRACTICAL LAB

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water

b. Alcohol
c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds.
(Boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Course Outcomes

At the end of this course a candidate will be able to understand –
CO-1. Basics of Organic Chemistry
CO-2. Stereochemistry:
CO-3. Carbon-Carbon sigma bonds
CO-4. Carbon-Carbon pi bonds:
CO-5. Cycloalkanes and Conformational Analysis
CO-6. Aromatic Hydrocarbons

ORGANIC CHEMISTRY -1							
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**3**	**2**	**2**	**2**	**3**	**2**	**3**
CO-2	**3**	**1**	**1**	**1**	**3**	**2**	**3**
CO-3	**3**	**2**	**2**	**3**	**3**	**2**	**3**
CO-4	**3**	**2**	**2**	**3**	**3**	**2**	**3**
CO-5	**3**	**2**	**2**	**3**	**3**	**2**	**3**
CO-6	**3**	**2**	**2**	**3**	**3**	**2**	**3**
CO-Average	**3**	**1.83**	**1.83**	**2.5**	**3**	**2**	**3**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

IV. BSCCHE-202:

PHYSICAL CHEMISTRY II

Course Objectives:

To provide students with the knowledge of physical chemistry

- Chemical Thermodynamics
- Systems of Variable Composition
- Criteria of thermodynamic equilibrium, degree of
- advancement of reaction
- Le Chatelier principle (quantitative treatment); equilibrium
- between ideal gases and a pure condensed phase
- Solutions and Colligative Properties
- Raoult's and Henry's Laws and their applications

I. Chemical Thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

II. Systems of Variable Composition:

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

III. Chemical Equilibrium:

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of

reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants *Kp, Kc* and *Kx*. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

IV. Solutions and Colligative Properties:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Reference Books

1. Peter, A. & Paula, J. de. Physical Chemistry 9 th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4 th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3 rd Ed., Prentice-Hall (2012).
4. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
5. Levine, I .N. Physical Chemistry 6 th Ed., Tata Mc Graw Hill (2010).
6. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

CHEMISTRY PRACTICAL LAB

Thermochemistry

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubility of benzoic acid in water and determination of ΔH.

Any other experiment carried out in the class.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Chemical Thermodynamics

CO-2. Systems of Variable Composition

CO-3. Criteria of thermodynamic equilibrium, degree of advancement of reaction

CO-4. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase

CO-5. Solutions and Colligative Properties

CO-6. Raoult's and Henry's Laws and their applications

PHYSICAL CHEMISTRY -2							
	PO-1	**PO- 2**	**PO- 3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**3**	**2**	**2**	**2**	**1**	**2**	**3**
CO-2	**3**	**1**	**1**	**1**	**1**	**2**	**3**
CO-3	**3**	**3**	**2**	**3**	**2**	**2**	**2**
CO-4	**3**	**3**	**2**	**3**	**2**	**3**	**1**
CO-5	**3**	**2**	**2**	**3**	**1**	**1**	**3**
CO-6	**3**	**2**	**2**	**3**	**1**	**2**	**3**
CO-Average	**3**	**2.17**	**1.83**	**2.5**	**1.33**	**2**	**2.5**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

---

SEMESTER III 5 Papers

I. SKILL ENHANCEMENT COURSE SEC 1:

IT SKILLS FOR CHEMISTS

Course Objectives:

To provide students with the knowledge of IT skills for chemists

- Basic Computer Concept
- Numbers Systems and Logic Gates
- Computer Software.
- Operating system-Windows
- Microsoft Power Point

A. INTRODUCTION TO COMPUTER SYSTEM

Basic Computer Concept

Computer Appreciation - Characteristics of Computers, Input, Output, Storage units, CPU, Computer System.

Input and Output Devices

Input Devices - Keyboard, Mouse, joystick, Scanner, web cam,

Output Devices- Soft copy devices, monitors, projectors, speakers, Hard copy devices, Printers – Dot matrix, inkjet, laser, Plotters.

Computer Memory and Processors

Memory hierarchy, Processor registers, Cache memory, Primary memory- RAM, ROM, Secondary storage devices, Magnetic tapes, Floppy disks, hard disks, Optical Drives- CD-ROM, DVD-ROM, CD-R, CD-RW, USB Flash drive, Mass storage devices: USB thumb drive. Managing disk Partitions, File System. Basic Processor Architecture, Processor speed, Types of processor.

Numbers Systems and Logic Gates

Decimal number system, Binary number system, Octal number system, Hexadecimal number system, Inter-conversion between the number systems. Basic Logic gates-AND, OR, NOT, Universal logic gates- NAND, NOR

Computer Software

Computer Software- Relationship between Hardware and Software, System Software, Application Software, Compiler, Names of some high level languages, Free domain software.

Internet & its uses

History of Internet, WWW and Web Browsers: Web Browsing software, Surfing the Internet, Chatting on Internet, Basic of electronic mail, Using Emails, Document handling, Network definition, Common terminologies: LAN, WAN, MAN, Node, Host, Workstation, Bandwidth, Network Components: Severs, Clients, Communication Media. Wireless network

Operating system-Windows

Operating system and basics of Windows, The User Interface, Using Mouse and Moving Icons on the screen, The My Computer Icon, The Recycle Bin, Status Bar, Start and Menu & Menu-selection, Running an Application, Windows Explorer Viewing of File, Folders and Directories, Creating and Renaming of files and folders, Opening and closing of different Windows, Windows Setting, Control Panels, Wall paper and Screen Savers, Setting the date and Sound, Concept of menu Using Help, Advanced Windows, Using right Button of the Mouse, Creating Short cuts, Basics of Window Setup, Notepad, Window Accessories

B. MICROSOFT OFFICE 2007 AND LATEST VERSIONS

Word Processing

Word processing concepts: saving, closing, Opening an existing document, Selecting text, Editing text, Finding and replacing text, printing documents, Creating and Printing Merged Documents, Character and Paragraph Formatting, Page Design and Layout. Editing and Checking. Correcting spellings. Handling Graphics, Creating Tables and Charts, Document Templates and Wizards, Mail merge and Macros.

Microsoft Excel (Spreadsheet)

Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Work Sheets, entering data in a cell / formula Copying and Moving from selected cells, handling operators in Formulae, Functions: Mathematical, Logical, statistical, text, financial, Date and Time functions, Using Function Wizard. Formatting a Worksheet: Formatting Cells changing data alignment, changing date, number, character or currency format, changing font, adding borders and colors, Printing worksheets, Charts and Graphs – Creating, Previewing, Modifying Charts. Integrating word processor, spread sheets, web pages. Pivot table, goal seek, Data filter and scenario manager

Microsoft Power Point (Presentation Package)

Creating, Opening and Saving Presentations, Creating the Look of Your Presentation, Working in Different Views, Working with Slides, Adding and Formatting Text, Formatting Paragraphs, Drawing and Working with Objects, Adding Clip Art and other pictures, Designing Slide Shows, Running and Controlling a Slide Show, Printing Presentations. Creating photo album, Rehearse timing and record narration. Master slides.

SKILL ENHANCEMENT LAB- SEC 1 LAB

A. MS-WORD LAB ASSIGNMENT

1. Write down the following Paragraph OR any one provided by your teacher;

Without a doubt, the Internet is one of the most important inventions of modern times. The Internet is a global interconnected computer networks which allow each connected computer to share and exchange information with each other. The origins of the Internet can be traced to the creation of Advanced Research Projects Agency Network (ARPANET) as a network of computers under the auspices of the U.S. Department of Defense in 1969.

Apply following effects on The paragraph:

i. Paragraph **font-size** and **font-type** must be 12 Verdana.
ii. Paragraph **alignment** must be justified and double line spacing.
iii. **Highlight** the "(ARPANET)" with green color.
iv. Make the "Internet" keywords **Bold and Italic**.
v. Insert any "**WordArt**" and a **symbol** to your document.
vi. Insert a **clipart** to your document.
vii. Add following lines to your document:

Internet, Intranet, Extranet, URL, WWW, Networking, Protocols, HTTP, TCP/IP

2. Create a Table of following fields:

Name, Surname, Age, Gender, Job and apply the following effects

i. Insert 10 records
ii. Font size should be 12
iii. Title size should be 14
iv. Font type should be Times new Roman
v. Title color should be blue
vi. Text color should be black
vii. Table border should be 2

3. Write a letter on 'Road Safety' and send to 'Multiple Recipients' using mail merge.

4. Type the paragraph given below:

Today, the Internet is a public, cooperative and self-sustaining facility accessible to hundreds of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (for Transmission Control Protocol/Internet Protocol). Two recent adaptations of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol. Today, the Internet is a public, cooperative and self-sustaining facility accessible to hundreds of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (for Transmission Control Protocol/ Internet Protocol). Two recent adaptations of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol.

Apply the following:

i. Change Internet into Internets at a time
ii. Heilight TCP/IP in red color
iii. Replace protocol into protocols
iv. Find the word "Public"

B. MICROSOFT EXCEL LAB ASSİGNMENT

Basic Formatting and Spreadsheet Manipulation

1. Add rows and columns to an existing spreadsheet
2. Reformat data (center, comma and currency styles, bold, text color)
3. Work with a simple formula (product) and function (sum)

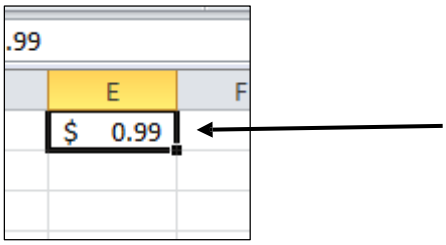
Assignment

1. Create a workbook as shown below.
2. To enter new rows or columns, simply click on the row or column header to select the whole row or column. Then right click with the mouse and choose insert.
3. Add the new row for S Spade with the data that's shown below (between the original rows 7 and 8).
4. Add a column for gender and the data as shown below (between the original columns A and B). Enter the appropriate gender for yourself in the last row.

	A	B	C	D
	Name	**Male/Female**	**Genre**	**Number of Songs**
	J Smith	F	Blues	50
	B Doe	M	Country	110
	S Spade	F	Country	200
	F Zappa	M	Blues	1400
	F Zappa	M	Alternative	2300
	J Smith	F	Alternative	150
	S Spade	F	Blues	1000
	B Doe	M	Blues	75
	Yourname	M	Blues	800

5. Center the data in columns B and C. Do this by selecting the whole column and click the center icon on the ribbon.
6. Bold the data in row 1, the column headings (ensure that the data all remains visible within the column boundaries).
7. Change the font color for row 1 to Blue.
8. Change the format of the data in column D to comma style (no decimal places showing).There is an icon on the home tab that sets it to comma style easily.
9. Add two new column labels to the right of the current columns; **Unit Price** and **Total Cost**. (They will be in columns E and F.) These two columns of data should be currency type so that the dollar sign is shown. There is an icon to quickly format the selected column as currency type.
10. All tunes are $.99, so enter that value for all rows in Column E. You can copy quickly by using the **Auto Fill** handle and drag that amount down. When you over your mouse over the tiny square in

the bottom right hand corner of the active cell, your mouse shape will become a skinny plus sign, and you can click and drag that cell to make a copy.



11. Calculate Total Cost (column F) as *column D times Column E*. You will type in a formula like this into cell F2: **=D2*E2** (Be sure to begin the formula with an equal sign)
12. Use the AutoFill (skinny plus sign) again to copy the formula down column F; down to F10. Double check the picture below to make sure yours has the correct values
13. Add a border to all of the cells (A1-f10) using the Borders tool in the Fonts group on the Home Tab.
14. Change the page layout to landscape. Do this by clicking the Page Layout tab on the ribbon and then to Orientation to Landscape.
15. Save the file.
16. Click in cell F11 and Use the sum function or the shortcut icon that looks like ∑ to get the total of the Total Cost column.
17. Ensure that the data is all visible within the column boundaries. Make the columns wider if needed.
18. Save the workbook. Your final spreadsheet should look like the following when printed.

Name	Male/Female	Genre	Number of Songs	Unit Price	Total Cost
J Smith	F	Blues	50	$ 0.99	$ 49.50
B Doe	M	Country	110	$ 0.99	$ 108.90
S Spade	F	Country	200	$ 0.99	$ 198.00
F Zappa	M	Blues	1,400	$ 0.99	$ 1,386.00
F Zappa	M	Alternative	2,300	$ 0.99	$ 2,277.00
S Spade	F	Blues	1,000	$ 0.99	$ 990.00
J Smith	F	Alternative	150	$ 0.99	$ 148.50
B Doe	M	Blues	75	$ 0.99	$ 74.25
yourname	M	Blues	800	$ 0.99	$ 792.00

$ 6,024.15

Create a sample table given below in Excel

- Using formula find Total
- Find the maximum value using MAX function from the **Units** column
- Find minimum value from **Total** column

Order Date	Region	Rep	Item	Units	Unit Cost	Total
1/6/2016	East	Jones	Pencil	95	1.99	189.05
1/23/2016	Central	Kivell	Binder	50	19.99	999.50
2/9/2016	Central	Jardine	Pencil	36	4.99	179.64
2/26/2016	Central	Gill	Pen	27	19.99	539.73
3/15/2016	West	Sorvino	Pencil	56	2.99	167.44
4/1/2016	East	Jones	Binder	60	4.99	299.40
4/18/2016	Central	Andrews	Pencil	75	1.99	149.25
5/5/2016	Central	Jardine	Pencil	90	4.99	449.10
5/22/2016	West	Thompson	Pencil	32	1.99	63.68
6/8/2016	East	Jones	Binder	60	8.99	539.40
6/25/2016	Central	Morgan	Pencil	90	4.99	449.10
7/12/2016	East	Howard	Binder	29	1.99	57.71
7/29/2016	East	Parent	Binder	81	19.99	1,619.19
8/15/2016	East	Jones	Pencil	35	4.99	174.65
9/1/2016	Central	Smith	Desk	2	125.00	250.00
9/18/2016	East	Jones	Pen Set	16	15.99	255.84
10/5/2016	Central	Morgan	Binder	28	8.99	251.72
10/22/2016	East	Jones	Pen	64	8.99	575.36
11/8/2016	East	Parent	Pen	15	19.99	299.85
11/25/2016	Central	Kivell	Pen Set	96	4.99	479.04
12/12/2016	Central	Smith	Pencil	67	1.29	86.43
12/29/2016	East	Parent	Pen Set	74	15.99	1,183.26

C. MS-POWERPOINT LAB ASSIGNMENT

Activity 1 : Using Text & Background/Themes

i. Create one new slide and insert any text.
ii. To make your slide more attractive, use the themes or background.
iii. Make sure it apply for every slide not only one slide.

Activity 2 : Apply Custom Animation On Text

i. Use the custom animation to add effects on your text. Set the text move after you click the mouse.
ii. If you have more than one text, add effects for each of text.

Activity 3 : Insert Image & WordArt

i. Insert one new blank slide.
ii. Choose one pictures or clip art from any source and insert in your new slide.
iii. Using the WordArt, make a note or title on your picture.
iv. Use the custom animation again to add effects on your picture and WordArt.

Activity 4 : Insert Text Box

i. Insert one new blank slide.
ii. Use the text box to insert one paragraph of text and adjust your text.

Activity 5 : Insert Smart Art

i. Insert one new blank slide.
ii. Insert the Smart Art and put your text on the Smart Art.

Activity 6 : Insert Audio

i. Back to your first slide and insert one audio on that slide. The audio must play automatically when you show your slide.
ii. Make sure the speaker also not appear when you show your slide. (the icon).
iii. The audio must play when you show alls your slide, not only one slide.

Activity 7 : inserting Video

i. Insert one new slide and insert one short video

Activity 8 : Save File

i. Save your file

Activity 9 : Create Photo Album & Hyperlink

i. Insert one new slide and put a text ex: “My Photo Album”
ii. Create one photo album and adjust your text and your photos
iii. Save your photo album with a new file
iv. Make a hyperlink to your photo using the text “My Photo Album”

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Basic Computer Concept
CO-2. Numbers Systems and Logic Gates
CO-3. Computer Software.
CO-4. Operating system-Windows
CO-5. Microsoft Power Point

IT SKILLS FOR CHEMISTS							
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**2**	**1**	**1**	**2**	**1**	**2**	**1**
CO-2	**2**	**1**	**1**	**1**	**1**	**2**	**1**
CO-3	**2**	**1**	**2**	**2**	**1**	**2**	**1**
CO-4	**2**	**1**	**2**	**2**	**1**	**3**	**1**
CO-5	**2**	**1**	**2**	**2**	**1**	**1**	**1**
CO-6	**2**	**1**	**1**	**2**	**1**	**2**	**1**
CO-Average	**2**	**1.00**	**1.50**	**1.83**	**1**	**2**	**1**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

II. GENERIC ELECTIVE (GE 3)

All Four Papers (One paper to be studied in each semester) of any One Subject to be opted other than the Honours Subject. Refer Content from the Syllabus of Opted Generic Elective Subject.

III. BSCCHE-301

INORGANIC CHEMISTRY-II

Course Objectives:

To provide students with the knowledge of Inorganic chemistry

- General Principles of Metallurgy
- Acids and Bases
- Chemistry of s and p Block Elements
- Allotropy and catenation
- Occurrence and uses, rationalization of inertness of noble gases,
- Clathrates
- Silicones and siloxanes. Borazines, silicates and phosphazenes,
- and polysulphates

I. General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

II. Acids and Bases

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

III. Chemistry of *s* and *p* Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.

Hydrides and their classification: Ionic, Covalent and Interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

IV. Noble Gases:

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

V. Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.

2.Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.

3.Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.

4.Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.

5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.

6.Shriver & Atkins, Inorganic Chemistry 5 th Ed.

CHEMISTRY PRACTICAL LAB

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically

(B) Inorganic preparations

(i) Cuprous Chloride, Cu_2Cl_2
(ii) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$
(iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Course Outcomes

At the end of this course a candidate will be able to understand –
CO-1. General Principles of Metallurgy
CO-2. Acids and Bases
CO-3. Chemistry of s and p Block Elements
CO-4. Allotropy and catenation
CO-5. Occurrence and uses, rationalization of inertness of noble gases, Clathrates
CO-6. silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates

INORGANIC CHEMISTRY-2							
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	2	2	2	2	1	2	3
CO-2	2	1	1	2	1	2	3
CO-3	3	2	2	2	2	2	2
CO-4	3	3	2	2	2	3	1
CO-5	2	2	2	2	1	1	3
CO-6	2	2	2	2	1	2	3
CO-Average	2.33	2.00	1.83	2	1.33	2	2.5

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

IV. BSCCHE-302:

ORGANIC CHEMISTRY-II

Course Objectives:
To provide students with the knowledge of organic chemistry

- Chemistry of Halogenated Hydrocarbons
- Alcohols, Phenols, Ethers and Epoxides
- Carbonyl Compounds
- Carboxylic Acids and their Derivatives
- Claisen condensation, Dieckmann and Reformatsky reactions
- Sulphur containing compounds

I. Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.
Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.
Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

II. Alcohols, Phenols, Ethers and Epoxides:

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism; *Ethers and Epoxides:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

III. Carbonyl Compounds:

Structure, reactivity and preparation:

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC);
Addition reactions of unsaturated carbonyl compounds: Michael addition.
Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

IV. Carboxylic Acids and their Derivatives:

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

V. Sulphur containing compounds:

Preparation and reactions of thiols, thioethers and sulphonic acids.

Reference Books:

1.Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3.Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

CHEMISTRY PRACTICAL LAB

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:

i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:

a. Using conventional method. b. Using green approach

ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-,

a. *m*-, *p*-anisidine) and one of the following phenols (β-naphthol, resorcinol, p-
b. cresol) by Schotten-Baumann reaction.

iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).

iv. Bromination of any one of the following:
   a. Acetanilide by conventional methods
   b. Acetanilide using green approach (Bromate-bromide method)

v. Nitration of any one of the following:
   a. Acetanilide/nitrobenzene by conventional method
   b. Salicylic acid by green approach (using ceric ammonium nitrate).

vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.

vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

viii. Hydrolysis of amides and esters.

ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

x. *S*-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

xi. Aldol condensation using either conventional or green method.

xii. Benzil-Benzilic acid rearrangement.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Chemistry of Halogenated Hydrocarbons
CO-2. Alcohols, Phenols, Ethers and Epoxides
CO-3. Carbonyl Compounds
CO-4. Carboxylic Acids and their Derivatives
CO-5. Claisen condensation, Dieckmann and Reformatsky reactions
CO-6. Sulphur containing compounds

ORGANIC CHEMISTRY -2							
	PO-1	PO- 2	PO- 3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	1	1	3	2	2
CO-2	3	1	1	2	3	2	2
CO-3	3	3	2	2	1	2	2
CO-4	3	3	1	3	3	3	2
CO-5	3	2	2	3	2	1	3
CO-6	3	2	2	3	3	2	2
CO-Average	3	2.17	1.50	2.33	2.5	2	2.17

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

V. BSCCHE-303:

PHYSICAL CHEMISTRY-III

Course Objectives:

To provide students with the knowledge of physical chemistry

- Phase Equilibria
- Chemical Kinetics
- Catalysis:
- Types of catalyst, specificity and selectivity, mechanisms of
- catalyzed reactions at solid surfaces
- Enzyme catalysi
- Physical adsorption, chemisorption, adsorption isotherms.

I. Phase Equilibria:

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

II. Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

III. Catalysis:

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

IV. Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

CHEMISTRY PRACTICAL LAB

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and
b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

V. Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.

3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption

1. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Phase Equilibria
CO-2. Chemical Kinetics
CO-3. Catalysis:
CO-4. Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces
CO-5. Enzyme catalysi
CO-6. Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.

PHYSICAL CHEMISTRY - 3

	PO-1	PO- 2	PO- 3	PO-4	PO-5	PO-6	PO-7
CO-1	2	2	2	2	2	2	2
CO-2	3	1	1	1	2	2	1
CO-3	3	1	1	3	2	1	2
CO-4	3	1	1	1	2	3	2
CO-5	2	2	2	1	1	1	3
CO-6	3	2	2	3	1	2	3
CO-Average	2.67	1.50	1.50	1.83	1.66	1.83	2.16

SEMESTER IV

I. SKILL ENHANCEMENT COURSE SEC 2:

FUEL CHEMISTRY

Course Objectives:

To provide students with the knowledge of fuel chemistry

- Review of energy sources (renewable and non-renewable)
- Classification of fuels and their calorific value. Coal
- Coal liquefaction and Solvent Refining
- Petroleum and Petrochemical Industry
- Classification of lubricants, lubricating oils

I. Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. *Coal:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

II. *Petroleum and Petrochemical Industry:* Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.
Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

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

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Course Outcomes

At the end of this course a candidate will be able to understand –
CO-1. Review of energy sources (renewable and non-renewable)
CO-2. Classification of fuels and their calorific value. Coal
CO-3. Coal liquefaction and Solvent Refining
CO-4. Petroleum and Petrochemical Industry
CO-5. Classification of lubricants, lubricating oils

	PO-1	PO- 2	PO- 3	PO-4	PO-5	PO-6	PO-7
CO-1	2	2	2	2	3	2	2
CO-2	3	1	2	1	3	2	1
CO-3	3	1	2	3	3	1	2
CO-4	3	2	2	1	3	3	3
CO-5	2	2	2	1	3	1	3
CO-Average	2.60	1.60	2.00	1.60	3.00	1.80	2.20

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

II. GENERIC ELECTIVE (GE 4)

III. BSCCHE-401:

INORGANIC CHEMISTRY-III

Course Objectives:

To provide students with the knowledge of inorganic chemistry

- Coordination Chemistry
- Crystal field theory
- Jahn-Teller theorem, square planar geometry. Qualitative aspect
- of Ligand field and MO Theory
- Chelate effect, polynuclear complexes, Labile and inert complexes
- Transition Elements
- Metal ions present in biological systems

I. Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

II. Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

III. Lanthanoids and Actinoids:

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

IV. Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium/ K-pump, carbonic anhydrase and carboxypeptidase. 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. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Reference Book

1.Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

CHEMISTRY PRACTICAL LAB

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxiMe)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Course Outcomes

At the end of this course a candidate will be able to understand –
CO-1. Coordination Chemistry
CO-2. Crystal field theory
CO-3. Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory
CO-4. Chelate effect, polynuclear complexes, Labile and inert complexes
CO-5. Transition Elements
CO-6. Metal ions present in biological systems

INORGANIC CHEMISTRY-3

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	2	2	2	3	2
CO-2	3	2	1	1	2	3	2
CO-3	3	2	1	3	2	3	2
CO-4	3	2	1	1	2	3	2
CO-5	3	2	2	1	1	3	2
CO-6	3	2	2	3	1	3	2
CO-Average	3.00	2.00	1.50	1.83	1.67	3	2

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

IV. BSCCHE-402:

ORGANIC CHEMISTRY-III

Course Objectives:

- Nitrogen Containing Functional Groups
- Polynuclear Hydrocarbons
- Heterocyclic Compounds
- Alkaloids
- Terpenes

I. Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles and isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

II. Polynuclear Hydrocarbons

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

III. Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction, Derivatives of furan: Furfural and furoic acid.

IV. Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action

Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

V. Terpenes

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009) 2.Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry:

4. Preparation and Quantitative Analysis, University Press (2000).

5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry:

6. Qualitative Analysis, University Press (2000).

CHEMISTRY PRACTICA LAB

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional
4. groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Course Outcomes

At the end of this course a candidate will be able to understand –

To provide students with the knowledge of organic chemistry

CO-1. Nitrogen Containing Functional Groups

CO-2. Polynuclear Hydrocarbons

CO-3. Heterocyclic Compounds

CO-4. Alkaloids

CO-5. Terpenes

ORGANIC CHEMISTRY -3							
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	2	3	2	2	3	2	2
CO-2	3	1	3	2	3	3	1
CO-3	3	1	3	3	2	1	1
CO-4	3	1	3	3	3	3	2
CO-5	2	2	2	3	3	1	3
CO-Average	2.60	1.60	2.60	2.60	2.80	2.00	1.80

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

V. BSCCHE-403:

PHYSICAL CHEMISTRY-IV

Course Objectives:

To provide students with the knowledge of physical chemistry

- Arrhenius theory of electrolytic dissociation.
- Conductivity, equivalent and molar conductivity and their variation
- with dilution for weak and strong electrolytes
- Kohlrausch law of independent migration of ions
- Debye-Hückel-Onsager equation
- Electrochemistry
- Electrical & Magnetic Properties of Atoms and Molecules

I. Conductance

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

II. Electrochemistry

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its

measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes.

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

III. Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGrawHill: New York (2003).

3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CHEMISTRY PRACTICAL LAB

Conductometry

i. Determination of cell constant

ii. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

iii. Perform the following conductometric titrations:
   a. Strong acid vs. strong base
   b. Weak acid vs. strong base
   c. Mixture of strong acid and weak acid vs. strong base
   d. Strong acid vs. weak base

Potentiometry

I. Perform the following potentiometric titrations:
   a. Strong acid vs. strong base
   b. Weak acid vs. strong base
   c. Dibasic acid vs. strong base
   d. Potassium dichromate vs. Mohr's salt

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Arrhenius theory of electrolytic dissociation.

CO-2. Conductivity, equivalent and molar conductivity and their variation

with dilution for weak and strong electrolytes
CO-3. Kohlrausch law of independent migration of ions
CO-4. Debye-Hückel-Onsager equation
CO-5. Electrochemistry
CO-6. Electrical & Magnetic Properties of Atoms and Molecules

PHYSICAL CHEMISTRY - 4							
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	3	3	2	2	2	2	2
CO-2	3	3	1	1	2	2	3
CO-3	3	3	1	3	2	2	2
CO-4	3	1	1	1	2	3	2
CO-5	2	2	2	1	1	2	3
CO-6	3	2	2	3	1	2	3

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

---

SEMESTER V

I. CHEMISTRY SPECIFIC (DSE 1):

ANALYTICAL METHODS IN CHEMISTRY

Course Objectives:

To provide students with the knowledge of analytical chemistry

- Qualitative and quantitative aspects of analysis
- Optical methods of analysis
- Thermal methods of analysis
- Electroanalytical methods
- Separation techniques
- NMR, . Chiral chromatographic techniques using chiral columns (GC
- and HPLC).

I. Qualitative and quantitative aspects of analysis:

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

II. Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

III. Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

IV. Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

V. Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation 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 nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

CHEMISTRY PRACTICAL-DSE 1 LAB:

I. Separation Techniques

1. Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

(i) 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.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. Analysis of soil:
(i) Determination of pH of soil.
(ii) Total soluble salt
(iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:
(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method

ANALYTICAL METHODS IN CHEMISTRY							
	PO-1	**PO- 2**	**PO- 3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**2**	**2**	**2**	**2**	**1**	**3**	**2**
CO-2	**2**	**1**	**1**	**1**	**2**	**3**	**3**
CO-3	**2**	**3**	**1**	**3**	**2**	**3**	**2**
CO-4	**3**	**2**	**1**	**1**	**2**	**3**	**3**
CO-5	**3**	**1**	**2**	**1**	**1**	**3**	**2**
CO-6	**3**	**2**	**2**	**3**	**1**	**3**	**2**
CO-Average	**2.50**	**1.8 3**	**1.5 0**	**1.83 3**	**1.5**	**3**	**2.33**

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Qualitative and quantitative aspects of analysis

CO-2. Optical methods of analysis

CO-3. Thermal methods of analysis

CO-4. Electroanalytical methods

CO-5. Separation techniques

CO-6. NMR, . Chiral chromatographic techniques using chiral columns (GC and HPLC).

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

II. CHEMISTRY SPECIFIC (DSE 2):

POLYMER CHEMISTRY

Course Objectives:

To provide students with the knowledge of polymer chemistry

- Introduction and history of polymeric materials
- Functionality and its importance
- Kinetics of Polymerization
- Crystallization and crystallinity
- Polymer Solution
- Brief introduction to preparation, structure, properties and
- application of the polymers

I. Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

II. Functionality and its importance:

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.

III. Kinetics of Polymerization:

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.

IV. Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

V. Nature and structure of polymers-Structure Property relationships.

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory-Huggins theory, Lower and Upper critical solution temperatures.

VI. Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, 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, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

CHEMISTRY PRACTICAL-DSE 2 LAB

Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
2. Purification of monomer
3. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
4. Preparation of nylon 66/6
5. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
6. a. Preparation of IPC b. Purification of IPC c. Interfacial polymerization
7. Redox polymerization of acrylamide
8. Precipitation polymerization of acrylonitrile
9. Preparation of urea-formaldehyde resin
10. Preparations of novalac resin/resold resin.
11. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq.$NaNO_2$ solution
   (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques 3. IR studies of polymers
4. DSC analysis of polymers 5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Introduction and history of polymeric materials
CO-2. Functionality and its importance
CO-3. Kinetics of Polymerization
CO-4. Crystallization and crystallinity
CO-5. Polymer Solution
CO-6. Brief introduction to preparation, structure, properties and application of the polymers

POLYMER CHEMISTRY

	PO-1	PO- 2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	2	1	3	2	3	2	2
CO-2	3	2	1	1	3	2	1
CO-3	2	1	1	3	3	2	2
CO-4	3	2	1	1	3	2	1
CO-5	3	2	2	1	3	2	2
CO-6	3	2	2	3	3	3	2
CO-Average	2.67	1.67	1.67	1.83	3	2.17	1.67

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

III. BSCCHE-501:

ORGANIC CHEMISTRY-IV

Course Objectives:

To provide students with the knowledge of organic chemistry

- Nucleic Acids
- Amino Acids, Peptides and Proteins
- Enzymes
- Lipids
- Concept of Energy in Biosystems
- Pharmaceutical Compounds: Structure and Importance

I. Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

II. Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification.

α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis.

III. Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

IV. Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

V. Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules).
Introduction to metabolism (catabolism, anabolism).

ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change.
Agents for transfer of electrons in biological redox systems: NAD^+, FAD.

Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.

Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

VI. Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

CHEMISTRY PRACTICAL LAB

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Nucleic Acids
CO-2. Amino Acids, Peptides and Proteins
CO-3. Enzymes
CO-4. Lipids
CO-5. Concept of Energy in Biosystems
CO-6. Pharmaceutical Compounds: Structure and Importance

ORGANIC CHEMISTRY -4

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	3	3	2	3	3	2
CO-2	2	2	3	1	3	3	2
CO-3	2	3	2	3	3	3	1
CO-4	3	2	3	1	3	3	3
CO-5	2	2	2	1	3	3	3
CO-6	3	2	2	3	3	3	2
CO-Average	2.50	2.33	2.50	1.83	3	3	2.17

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

IV. BSCCHE-502:

PHYSICAL CHEMISTRY V

Course Objectives:

To provide students with the knowledge of physical chemistry

- Quantum Chemistry
- Schrödinger equation and its application to free particle and
- "particle-in-a-box"
- Covalent bonding, valence bond and molecular orbital approaches
- Molecular Spectroscopy
- Photochemistry
- Lambert-Beer's law and its limitations

I. Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of S chrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression).

Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

II. Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.
Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.
Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.
Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

III. Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

CHEMISTRY PRACTICAL LAB

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.
III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a

solution of unknown concentration

II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1,10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Quantum Chemistry

CO-2. Schrödinger equation and its application to free particle and "particle-in-a-box"

CO-3. Covalent bonding, valence bond and molecular orbital approaches

CO-4. Molecular Spectroscopy

CO-5. Photochemistry

CO-6. Lambert-Beer's law and its limitations

PHYSICAL CHEMISTRY -5

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	2	2	1	3	2
CO-2	3	2	1	1	1	2	3
CO-3	3	2	3	3	1	3	2
CO-4	3	3	1	1	2	3	3
CO-5	3	2	2	1	1	2	2
CO-6	3	2	2	3	1	3	2
CO-Average	3.00	2.17	1.83	1.83	1.17	2.67	2.33

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

---

SEMESTER VI

I. CHEMISTRY SPECIFIC (DSE 3):

Bio-Inorganic Chemistry

Course Objectives:

To provide students with the knowledge of Bio-Inorganic chemistry

I. Essential and trace elementsin in biological processes :metals like Fe, Cu, Se, Cr and Mo. Essential and tracenon-metals : like P (in the form of Phosphate), Iodine and Chlorine.

II. Essential Bulk Elements :

Na and K, Ca and Mg in the form of Na^+ / K^+ and Ca^{2+} / Mg^{2+}. Biological roles of alkali and alkaline earthmetal ions

III. Metallomorphyrins

IV. Transport and Storage of Dioxygen :Hemeproteins and oxygen uptake, Haemoglobin and myoglobin functions and co-operativity, structures of haemoglobin and myoglobin. Role of hemoglobin and myoglobin. Oxidation and oxygenation of Hb and Mb.

V. Nitrogenase : Biological Nitrogen fixation.

VI. Metals in medicines, Metal deficiency and diseases, Toxic effects of metals.

Book Recommended

Bio-Inorganic Chemistry

1. Bio Inorganic Chemistry by K. Hussain Reddy
2. General Chemistry by R.C. Sarkar
3. Bio Inorganic Chemistry by Kalsi

Course Outcomes

At the end of this course a candidate will be able to understand –

- Understanding Bio-Inorganic Chemistry
- Essential and trace elementsin in biological processes
- Essential Bulk Elements
- Metallomorphyrins
- Haemoglobin and myoglobin functions and co-operativity, structures of haemoglobin and myoglobin
- Nitrogenase : Biological Nitrogen fixation.
- Metals in medicines

BIO-INORGANIC CHEMISTRY							
	PO-1	**PO- 2**	**PO- 3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO-2	**3**	**2**	**1**	**1**	**2**	**3**	**2**
CO-3	**3**	**2**	**3**	**3**	**2**	**3**	**2**
CO-4	**3**	**2**	**1**	**1**	**2**	**2**	**3**
CO-5	**3**	**2**	**3**	**1**	**1**	**2**	**3**
CO-6	**3**	**2**	**2**	**2**	**1**	**3**	**2**
CO-6	**3**	**2**	**2**	**3**	**1**	**3**	**2**
CO-Average	**3.00**	**2.00**	**2.00**	**1.86**	**1.57**	**2.57**	**2.29**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

II. CHEMISTRY SPECIFIC (DSE 4):

Bio-Organic Chemistry

Course Objectives:

To provide students with the knowledge of Bio-organic chemistry

- Understanding Bio-Organic Chemistry
- Enzymes
- Mechanism of enzyme action
- Bio-technological application of enzyme
- Clinical uses of enzymes
- Co-enzymes

I. Enzymes :

Introduction and historical perspective Chemical and Biological Catalysis.Nomenelature, classification andextraction of Enzymes, Enzyme inhibition – Reversible and irreversible.

II. Mechanism of enzyme action :

Examples of some typical enzyme mechanism

(a) Transition State theory

(b) Acid-base Catalysis

(c) Covalent Catalysis

III. Bio-technological application of enzymes :

Use of enzymes in feed and drink industries

IV. Clinical uses of enzymes :

(d) Mutations and genetic diseases.

(e) Enzyme therapy and recombinant DNA technology.

V. Co-enzymes :

Structure and biological function of co-enzyme A, co-factors as derived from vitamins, vitamin-B12.

Book Recommended

Bio-Organic Chemistry

1. Bio-Organic and Inorganic Chemistry by P.S. Kalsi

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Understanding Bio-Organic Chemistry
CO-2. 1.Enzymes
CO-3. Mechanism of enzyme action
CO-4. Bio-technological application of enzyme
CO-5. Clinical uses of enzymes
CO-6. Co-enzymes

BIO-ORGANIC CHEMISTRY							
	PO-1	**PO- 2**	**PO- 3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**3**	**2**	**2**	**2**	**3**	**3**	**2**
CO-2	**3**	**2**	**2**	**1**	**3**	**3**	**2**
CO-3	**3**	**2**	**1**	**3**	**3**	**3**	**3**
CO-4	**3**	**2**	**2**	**1**	**3**	**3**	**2**
CO-5	**3**	**2**	**2**	**1**	**3**	**3**	**3**
CO-6	**3**	**2**	**2**	**3**	**3**	**3**	**2**
CO-Average	**3.00**	**2.00**	**1.83**	**1.83**	**3**	**3**	**2.33**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

I. BSCCHE-601:

INORGANIC CHEMISTRY-IV

Course Objectives:

To provide students with the knowledge of Inorganic chemistry

- Theoretical Principles in Qualitative Analysis
- Basic principles involved in analysis of cations and anions and solubility
- products, common ion effect
- Organometallic Compounds
- Zeise's salt: Preparation and structure, evidences of synergic effect
- and comparison of synergic effect with that in carbonyls
- Ferrocene: Preparation and reactions
- Reaction Kinetics and Mechanism

I. Theoretical Principles in Qualitative Analysis (H_2S Scheme)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

II. Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type.
Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. 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.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

III. Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar omplexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

IV. Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

CHEMISTRY PRACTICAL LAB

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-},$C_2O_4^{2-}$, PO_4^{3-}, NH_4^+,K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

Mixtures should preferably contain:

i. one interfering anion, **or**
ii. iinsoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) **or**
iii. combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-.

Spot tests should be done whenever possible.

i. Measurement of 10 Dq by spectrophotometric method
ii. Verification of spectrochemical series.
iii. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs
iv. thermodynamic factors.
v. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Find the λ_{max} of the complex.
vi. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g.
vii. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Course Outcomes

At the end of this course a candidate will be able to understand –

CO-1. Theoretical Principles in Qualitative Analysis

CO-2. Basic principles involved in analysis of cations and anions and solubility products, common ion effect

CO-3. Organometallic Compounds
CO-4. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls
CO-5. Ferrocene: Preparation and reactions
CO-6. Reaction Kinetics and Mechanism

INORGANIC CHEMISTRY-4							
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**
CO-1	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO-2	**3**	**2**	**2**	**1**	**1**	**3**	**1**
CO-3	**2**	**3**	**2**	**2**	**2**	**2**	**2**
CO-4	**3**	**3**	**1**	**1**	**2**	**3**	**2**
CO-5	**3**	**2**	**2**	**1**	**1**	**3**	**2**
CO-6	**3**	**2**	**2**	**3**	**1**	**3**	**2**
CO-Average	**2.67**	**2.33**	**1.83**	**1.67**	**1.5**	**2.67**	**1.83**

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

II. BSCCHE-602:

ORGANIC CHEMISTRY-V

Course Objectives:

To provide students with the knowledge of organic chemistry

- Undestanding Organic Spectroscopy
- NMR Spectroscopy
- Carbohydrates
- Dyes
- Polymers
- Fabrics – natural and synthetic

I. Organic Spectroscopy

General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules.

II. Carbohydrates

Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration 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 – Structure elucidation of maltose, lactose and sucrose.
Polysaccharides – Elementary treatment of starch, cellulose and glycogen.

III. Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet;
Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

IV. Polymers

Introduction and classification including di-block, tri-block and amphiphilic polymers;
Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.

Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives;
Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.

CHEMISTRY PRACTICAL LAB

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

Course Outcomes

At the end of this course a candidate will be able to understand –
CO-1. Undestanding Organic Spectroscopy
CO-2. NMR Spectroscopy
CO-3. Carbohydrates
CO-4. Dyes
CO-5. Polymers
CO-6. Fabrics – natural and synthetic

ORGANIC CHEMISTRY -5

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	2	2	2	3	2
CO-2	3	2	1	1	2	3	2
CO-3	3	2	1	3	2	3	2
CO-4	3	2	1	1	2	3	2
CO-5	3	2	2	1	1	3	2
CO-6	3	2	2	3	1	3	2
CO-Average	3.00	2.00	1.50	1.83	1.67	3	2

3 is strongly mapped , 2 is moderately mapped, 1 is slightly mapped and 0 is non-mapped

M. K. Mishra

Head
Department of Chemistry
Netaji Subhas University

NETAJI SUBHAS UNIVERSITY Jamshedpur

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand