CHEMISTRY (B.Sc) Life Sciences Effective from 2014
(Inorganic Chemistry-I)

Paper Code:		Semester Exam:	70 Marks
Instruction:	4 h / week	Duration:	3 hours
		Internal Assessment:	30 Marks

UNIT-I Atomic Structure and Chemical Bonding:

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, 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

Chemical bonding :

Valence bond theory, hybridization, VB theory as applied to ClF_3, BrF_5, $Ni(CO)_4$, XeF_2. Dipole moment – orientation of dipoles in an electric field, dipole moment, induced dipole moment, dipole moment and structure of molecules. Molecular orbital theory – LCAO method, construction of M.O. diagrams for homo-nuclear and hetero-nuclear diatomic molecules (N_2, O_2, HCl, CO and NO). Comparison of VB and MO theories. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetic of dissolution process.

Unit - 2 Periodicity of Elements:

Modern Periodic Law and the long form of periodic table. Classification of elements on the basis of electronic configuration (s, p, d and f – block elements). Detailed discussion of the following properties of the elements with reference to s and p-block.
i)Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. ii) Atomic radii (van der Waals) iii) Ionic and crystal radii. iv) Covalent radii (octahedral and tetrahedral) v) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. vi) Electron gain enthalpy, trends of electron gain enthalpy. vii) 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. Diagonal, relationship between Li & Mg, Be & Al. and anamalous behavior of first member of each group.

Unit – 3 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. Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

UNIT- -IV ***Acids and Bases and Inorganic Polymers:***

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.

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.

CHEMISTRY LAB – 1

Paper Code: OP 153(i)	Semester Exam: 35 Marks
Instruction: 3 h / week	Duration: 3 hours
	Internal Assessment: 15 Marks

1. Analysis of one anions and one cation from a given of salt.

Cations : NH_4^+ , Pb^{2+} ,, Bi^{3+} , Cu^{2+} , Cd^{2+} , Fe^{3+} , Al3+, Co^{3+} , Ni^{2+} , Mn^{2+} , Zn^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} . Mg^{2+}
Anions : CO_3^{2-} , $S^{2-,}$ SO_3^{2-} , NO_3^- , CH_3COO^-, Cl^- , Br^- , I^- , SO_4^{2-} , PO_4^{3-} , BO_3^{3-}
2. Determination of carbonate and bicarbonate in a mixture

3. Determination of Fe(II) using $K_2Cr_2O_7$

4. Determination of Fe(II) using $KMnO_4$ with oxalic acid as primary standard.

5. Determination of Cu(II) using $Na_2S_2O_3$ with $K_2Cr_2O_7$ as primary standard

6. Determination of Zinc using EDTA

7. Determination of hardness of water

8. Determination of Zinc by Ferro cyanide

CHEMISTRY -2
(Organic Chemistry-I)

Paper Code:		Semester Exam: Marks	70
Instruction:	4 h / week	Duration:	3 hours
		Internal Assessment: Marks	30

Unit – 1 **Structural theory in Organic Chemistry:**

Types of bond fission and organic reagents (Electrophilic, Nucleophilic, and free radical reagents including neutral molecules like H_2O, NH_3 & $AlCl_3$).
Bond polarization : Factors influencing the polarization of covalent bonds, electro negativity. Inductive effect - Application of inductive effect on basicity of amines, acidity of carboxylic acides, stability of carbonium ions, carbanions. free radicals, carbenes. Resonance or Mesomeric effect - Application to acidity of phenol and carboxylic acids. Hyper conjugation - Stability of carbonium ions, Free radicals, carbanions, carbenes and nitrenes.
Types of Organic reactions: Addition-electrophilic, nucleophilic and free radical. Substitution-electrophilic, nucleophilic and free radical. Elimination- Examples (mechanism not required).

Unit – 2 Stereochemistry of carbon compounds:
Three dimensional structures of organic molecules and Molecular representations- Wedge, Fischer, Newman and Saw-horse formulae.Homomers, Isomers, Constitutional isomers (chain, positional, functional), Stereoisomers,

Enantiomers and Diastereomers, Configurational and Conformational stereoisomers – definitions and examples.

Optical Isomerism, optical rotation and specific rotation. Enantiomers, Racemic mixture- racemisation and resolution techniques. Chiral center, Chiral molecules- , Molecules with similar and dissimilar chiral carbons – examples - tartaric acid and 2,3-dibromopentane - definition of mesomers - formulae for calculating the number of stereoisomers. D and L configuration, R &S configuration in molecules with chiral centres – CIP rules. Geometrical isomerism in alkenes- Cis & Trans, E & Z- configuration

Unit- 3 Aromatic and Acyclic Hydrocarbons

Aromatic hydrocarbons Preparation (Case benzene): from phenol, bydecarboxylation, from acetylene, from benzene sulphonic acid. Reactions:(Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene)

Alkanes– IUPAC Nomenclature of Hydrocarbons. Methods of preparation: Hydrogenation of alkynes and alkenes, Wurtz reaction, Kolbe's electrolysis, Free radical substitution mechanism. Halogenation. **Alkenes –** Preparation of alkenes by (a) dehydration of alcohols (b) dehydrohalogenation of alkyl halides, Saytzev's rule. trans alkenes (Birch reduction) Reactions :Addition of halogen and its mechanism. Addition of HX, Markonikov's rule, addition of H2O, HOX, H2SO4 and addition of HBr in the presence of peroxide (anti – Markonikov's addition). Ozonolysis, Oxidation – hydroxylation by KMnO4 , OsO4, peracids (via epoxidation) hydroboration oxidation, Oxymercuration and demercuration, Dienes – Types of dienes, reactions of conjugated dines – 1,2 and 1,4 addition of HBr to 1,3 – butadiene and Diel's – Alder reaction. **Alkynes –** Preparation : Acetylene from CaC2 and conversion into higher alkynes; by dehydrohalogenation of dihalides, dehalogenation of tetrahalides, Reactions ; formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alkaline KMnO4.

Unit – 4 Functional group – I

Alkyl and Aryl Halides

Nomenclature and classification of alkyl (into primary, secondary, tertiary), aryl, aralkyl, allyl, vinyl, benzyl halides. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution Nucleophilic aliphatic substitution reaction- Classification into SN1 and SN2. Energy profile diagram of SN1 and SN2 reactions. Stereochemistry of SN2 (Walden Inversion) SN1 (Racemisation). Explanation of both by taking the example of optically active alkyl halide – 2bromobutane. Ease of hydrolysis – comparision of alkyl, benzyl, alkyl, vinyl and aryl halides Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Alcohols, Phelos and ether.

Preparation of alcohols from alkene by hydroboration oxidation reaction, Grignard synthesis of alcohols. Preparation of phenols from diazonium salt, aryl sulphonates, from cumene.

Reactions : acidic nature of phenols.formation of alkoxides/phenoxides and their reaction with RX. replacement of OH by X using PCl_5, PCl_3, PBr_3,$SOCl_2$ and with HX/$ZnCl_2$. esterification by acids (mechanism).dehydration of alcohols.oxidation of alcohols by CrO_3, $KMnO_4$.

Reaction of phenols: Bromination, Kolb-Schmidt reaction, Riemer-Tiemann reaction, , Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction,azocoupling.

Identification of alcohols by oxidation with $KMnO_4$, ceric ammonium nitrate, lucas reagent and phenols by reaction with $FeCl_3$. Polyhydroxy compounds: Pinacol-Pinacolone rearrangement.Ethers (aliphatic and aromatic): Cleavage of ethers with HI.Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetoneand benzaldehyde) Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

CHEMISTRY LAB – 2

Paper Code:		Semester Exam: Marks	35
Instruction:	3 h / week	Duration: hours	3
		Internal Assessment: Marks	15

1. Identification of elements (N, S, X = Cl, Br and I, and both n & S present together) in an organic compound.
2. Identification of unknown organic compounds containing mono-functional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bi-functional groups, e.g. salicylic acid, cinnamic acid, nitrophenols, etc
3. Preparation of methyl orange and aspirin.
4. Separation of a mixture of amino acids by paper chromatography.
5. Separation of a mixture of o- and p- nitrophenol by thin layer chromatography(TLC)
6. Determination of optical activity by using polarimeter.

CHEMISTRY -3
(Physical Chemistry-I)

Paper Code:		Semester Exam:	35 Marks
Instruction:	4 h / week	Duration:	3 hours
		Internal Assessment:	15 Marks

Unit – 1 States of Matter

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square
velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on
surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Unit – 2. Thermo chemistry:

Important Principles and definition of thermo chemistry, 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 thermo chemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.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. Statement of second and third law of thermodynamics.

Unit - 3 Chemical Equilibrium and Ionic Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔGo,LeChatelier'sprinciple. Relationships between Kp, Kc and Kx for reactions involving ideal gases. Strong, moderate and weak electrolytes, degree of ionization, factors ffecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit – 4. Chemical Kinetics

Rate of reaction, factors influencing the rate of a reaction-concentration, temperature, pressure, solvent, light, catalyst. Experimental methods to determine the rate of reaction. Definition of order and molecularity. Derivation of Integrated rate equations for zero, first and second order reactions (both for equal and unequal concentration of reactants). Derivation for time half change. Methods to determine the order of reactions. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy and its calculation from Arrhenius equation. Theories of reaction rates- collision theory and activated complex theory of bimolecular reaction.

CHEMISTRY-III

(Physical Chemistry-I)

Paper Code: OP)	Semester Exam: 35 Marks
Instruction: 3 h / week	Duration: 3 hours
	Internal Assessment: 15 Marks

1. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

2. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Oswald's viscometer.

3. Determination of heat capacity of calorimeter for different volumes.
4. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
5. Determination of enthalpy of hydration of copper sulphate.
6. Prereparation of sodium acetate – acetic acid buffer solutions and measurement of their pH.
7. Potentiometric titrations of (i) strong acid vs strong base (ii) weak acid vs strong base (iii) strong acid vs weak base .
8. Determination of dissociation constant of weak acids.
9. Study the kinetics of the Iodide-persulphate reaction by Initial rate method
10. Study the kinetics of the i) acid hydrolysis of methyl acetate with hydrochloric acid ii) Saponification of ethyl acetate by Integrated rate method.

Chemistry -4

(Physical Chemistry-II & Inorganic Chemistry-II)

Paper Code:	Semester Exam: 70 Marks
Instruction: 4 h / week	Duration: 3 hours
	Internal Assessment: 30 Marks

Unit – 1. Conductance and Electrochemistry:

Specific conductance, equivalent conductance, measurement of equivalent conductance. Variation of equivalent conductance with dilution. Migration of ions, Kohlrausch's law. Arrhenius theory of electrolyte dissociation and its limitations. Ostwald's dilution law. Debye-Huckel-Onsagar's equation for strong electrolytes (elementary treatment only). Definition of transport number, determination by Hittorf's method. Application of conductivity measurements-determination of dissociation constant (K_a) of an acid, determination of solubility product of sparingly soluble salt, conduct metric titrations (only acid – base).

Types of reversible electrodes- the gas electrode, metal-metal ion, metal-insoluble salt and redox electrodes. Electrode reactions, Nernst equation, single electrode potential, standard Hydrogen electrode, reference electrodes, standard electrode potential, sign convention, electrochemical series and its significance. Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Computation of cell EMF. Applications of EMF measurements, Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K). Determination of pH using

quinhydrone electrode, Solubility product of AgCl. Potentiometric titrations – qualitative treatment (acid – base and oxidation – reduction only).

Unit – 2. Phase Equilibrium:

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

Unit – 3. Transition elements :

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu Lanthanoids and Actinoids: Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit -4 Coordination Chemistry :

Werner's 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. valence bond theory (inner and outer orbital complexes), Drawbacks of VBT. Crystal Field Theory, Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Spectrochemical series.

CHEMISTRY-IV

(Physical Chemistry-II and Inorganic Chemistry II)

Paper Code: OP)	Semester Exam: 35 Marks
Instruction: 3 h / week	Duration: 3 hours
	Internal Assessment: 15 Marks

1. Determination of cell constant
2. Perform the following conductometric titrations: (i) Strong acid vs. strong base(ii) Weak acid vs. Strong base
   i) Perform the following potentiometric titrations: (i) Strong acid vs. strong
3. base (ii) Weak acid vs. strong base (iii) Potassium dichromate vs. Mohr's salt

4. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
5. Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
6. Analysis of two anions and two cations from a mixture of salt.
7. **Cations :** NH_4^+ , Pb^{2+} „ Bi^{3+} , Cu^{2+} , Cd^{2+} , Fe^{3+} , Al3+, Co^{3+} , Ni^{2+} , Mn^{2+} , Zn^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} . Mg^{2+}
   Anions : CO_3^{2-} , $S^{2-,}$ SO_3^{2-} , NO_3^- , CH_3COO^-, Cl^- , Br^- , I^- , SO_4^{2-} , PO_4^{3-} , BO_3^{3-}

8. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound (KMnO4/ CuSO4) and estimate the concentration of the same in a given solution.

9. Preparation of the following complexes.
   i) Tetraamminecopper (II) sulphate, [Cu(NH3)4]SO4.H2O
   ii) Potassium tris(oxalate)ferrate(III)
10. Estimation of nickel (II) using Dimethylglyoxime (DMG)

Recommended Text and Reference Books:

1. Text book of Physical Chemistry by P.L.Soni, O.P.Dharmarha and Q.N.Dash
2. Physical chemistry through problems By S K Dogra
3. Advanced Physical Chemistry by Puri & Sharma.
4. Basic Concept of Physical Chemistry by P. L. Soni.
5. Senior's practical physical chemistry by Khosla

1. Concise Inorganic Chemistry by J.D.Lee
2. Advanced Inorganic chemistry by Puri & Sharma.
3. Advanced Inorganic Chemistry by P. L. Soni.
4. A textbook of qualitative inorganic analysis by A.I. Vogel

Syllabus based on CBCS effective from 2016-

Course Code	**BCH201CCT**		**Semester**
Course title	**Conceptual Organic Chemistry**		1

Scheme of Instruction			**Scheme of Examination**		
Total Duration	:	60 Hrs	Maximum Score	:	70
Periods / Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Examination hours	:	3 Hrs

Course Objectives: Stereochemistry of organic compounds and knowledge of different types of reactions in organic compounds with their mechanism.

Course Outcomes: Acquaintance with differentiation among addition, substitution and elimination organic reactions. Concepts of organic oxidation and reduction reactions and stereochemistry.

Unit	Course Content	Instruction Hours
1	**Stereochemistry** Isomerism, Classification of isomerism, Structural and stereo isomerism, Geometrical and optical isomerism, requirements for a molecule to show geometrical isomerism, Cis- trans isomerism, Eand Z notation along with CIP rules for geometrical isomers. Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute	15

	configuration, D & L nomenclature system for configuration of carbohydrates, R and S configuration (upto two chiral centres).	
2	**Addition Reactions** **Addition reactions** in alkenes and alkynes, hydrogenation, addition of halogen Hydrohalogenation (Markovnikov,s and anti- Markovnikov,s addition) hydration, , Hydroboration-oxidation and Oxymercuration- demercuration.Ozonolysis, Reactivity of alkenes vs alkynes. **Addition reactions** in aldehydes and ketones (formaldehyde, acetaldehyde, benzaldehyde, acetone). Name reactions; aldol, cross aldol, Claisen, Knovengel, Cannizzaro, cross Cannizzaro. Reaction.	15
3	**Substitution Reactions** Types of substitution reactions, Electrophilic substitution reactions, General mechanism of electrophilic substitution ractions (nitration, halogentaion, sulphonation, Friedal Crafts alkylation and acylation), directive influence of substituent's. Nucleophilic substitution reactions, alkyl, allyl and benzyl halides, substitution of halogen by some common nucleophiles. Mechanism of SN^1 and SN^2 reactions, free radical substitution reactions, halogenations of alkanes, allylic compounds and alkyl benzenes.	15
4	**Elimination, Oxidation and Reduction Reactions** Alkyl halides (dehydrogenation, Saytzeff,s rule), vicinal dihalides (dehalogenation), alcohols (Dehydration), Mechanism of E1 and E2 reactions (nature of substrate and base). **Oxidation** of alcohols with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Opppenauer oxidation and oxidation of 1,2- diols with periodic acid and lead tetra acetate. Oxidation of aldehydes and ketones with potassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer- villager oxidation.	15

	Reduction of aldehydes and ketones, Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, and Wolff- kishner reduction. Reduction of carboxylic acids and their derivatives, lithium aluminium hydride, sodium- ethanol and Rosenmund reduction. Reduction of nitro compounds, Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.	
Examination and Evaluation Pattern :		
Text Books and References :		
1	I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.	
2	R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.	
3	Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand	
4	Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.	
5	Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994. 6. T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.	
6	P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons. 8. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers	

Course Code	**BSCH150CCP**	**Semester**	
Course title	**Conceptual Organic Chemistry**	1	

Scheme of Instruction

Total Duration : 60Hr

Periods /Week : 4

Credits : 2

Instruction Mode : Lecture /Demonstration

Scheme of Examination

Maximum Score : 50

Internal Evaluation : 15

End Semester : 35

Exam Duration : 3 Hrs

Course Objectives: Synthesis and qualitative analysis of organic compounds as well as the identification of inorganic elements.

Course Outcomes: Understanding the utility of qualitative inorganic and organic analysis procedures.

Unit	Course Content	Instruction Hours
	List of Experiments: 1. Detection of elements (X, N, S) 2. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group 3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds) 4. Determination of optical activity by using polarimeter 5. To prepare p-bromo acetanilide 6. Nitration of nitrobenzene 7. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde. 8. Oxidation of benzaldehyde by using alkaline potassium permanganate.	60Hrs
Examination and Evaluation Pattern :		
Text Books and References :		

1	Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)	
2	Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).	

Course Code **BCH 201CCT** **Semester** 2

Course Title **Molecules of Life**

Scheme of Instruction

Total Duration : 60Hr

Periods /Week : 4

Credits : 4

Instruction Mode : Lecture

Scheme of Examination

Maximum Score : 100

Internal Evaluation : 30

End Semester : 70

Exam Duration : 3 Hrs

Course Objectives: In –depth studies regarding classification, properties and uses of biomolecules.

Course Outcomes: Better understanding about the relationship between structures and chemical properties of biomolecules. Significance of biomolecules and their applications in daily human life

Unit	Course Content	Instruction Hours
1	**Carbohydrates:** Introduction, Classification of carbohydrates, Reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, anomers and muta rotation. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucpse. Haworth projections. Cyclic structure of fructose. Chain lengthening and chain shortening of aldoses. Linkage between monosachharides, structure of disachharides (sucrose, maltose, lactose) and polysachhharides (starch and cellulose) excluding their structure elucidation.	15
2	**Amino Acids, Peptides and Proteins:** Introduction, Classification of amino acids, general properties of amino acids, Zwitterions structure and isoelectric point. Peptides, classification of peptides, Synthesis of simple peptides up to dipeptides, Merrifield solid phase peptide synthesis. Classification of proteins, Denaturation and renaturation of proteins, Overview of primary, secondary , tertiary and	15

	quaternary structure of proteins, determination of n- terminal amino acid by DNFB and Edman method.	
3	**Vitamins and Nucleic Acids:** Classification of vitamins, Sources of vitamins, diseases caused by deficiency of vitamins, Detail study of structure of vitamin A and C. Components of Nucleic acids, Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), structure of polynucleotide's, Structure of DNA (Watson- crick model) and RNA and its type, Difference between DNA and RNA.	15
4	**Lipids, Oil and Fats:** Introduction to lipids, classification of lipids, Common fatty acids present in oils and fats, omega fatty acids, trans fats, hydrogenation, saponification value, Iodine number, Biological importance of triglycerides, phospholipids, glycolipids and steroids (cholesterol).	15
Examination and Evaluation Pattern :		
Text Books and References :		
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	Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand	
4	Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).	
5	Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman	
6	Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.	

MANUU - Department of Chemistry School of Sciences

Course Code **BSCH 250CCT** **Semester**

Course Title **Molecules of Life** **2**

Scheme of Instruction
Total Duration : 60Hr
Periods /Week : 4
Credits : 2
Instruction Mode : Lecture /Demonstration

Scheme of Examination
Maximum Score : 50
Internal Evaluation : 15
End Semester : 35
Exam Duration : 3 Hrs

Course Objectives: Identification, separation and determination of organic compounds of pharmaceutical importance.

Course Outcomes: The students will be capable to use chromatographic as well as volumetric methods for determination of biomolecules in different matrices.

Unit	Course Content	Instruction Hours
	List of Experiments: 1. Separation of amino acids by paper chromatography 2. To determine the concentration of glycine solution by formylation method. 3. Study of titration curve of glycine 4. Resolution of water soluble vitamins from their by normal phase silica thin layer chromatography (NTLC) 5. To determine the saponification value of an oil/fat. 6. To determine the iodine value of an oil/fat 7. Differentiate between a reducing/nonreducing sugar. 8. Synthesis of aspirin by acetylation of salicylic acid and application of TLC for its identification in drug sample.	60Hrs
Examination and Evaluation Pattern :		
Text Books and References :		
1	Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)	
2	Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).	
3	Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)	

Semester-3

Course Code **BCH 301CCT**

Course Title **Chemical Bonding, Transition Metals & Coordination Chemistry**

Scheme of Instruction		Scheme of Examination	
Total Duration	: 60Hr	Maximum Score	: 100
Periods /Week	: 4	Internal Evaluation	: 30
Credits	: 4	End Semester	: 70
Instruction Mode	: Lecture	Exam Duration	: 3 Hrs

Course Objectives: Extended physico- chemical knowledge about chemical bonding, transition elements and coordination chemistry.

Course Outcomes: Better understanding about the formation of organic and inorganic compounds through chemical bonding. Conceptual knowledge of complex compounds and physical as well as chemical aspects of transition metals.

Unit	Course Content	Instruction Hours
1	**Chemical Bonding** Valence bond approach, Concept of resonance in various organic inorganic compounds, Hybridization and structure, equivalent and n equivalent hybrid orbital's, Bent's rule and its applications, VSE model for predicting shapes of molecules and ions containing lone p sigma and pi bonds. LCAO method, symmetry and overlap for s-s , and p-p combinations, MO treatment of homonuclear diatomic molecu of 2nd period (B_2, C_2, N_2, O_2,F_2) and heteronuclear di-atomic molecu (CO, NO) and their ions. Van der Waals forces, Hydrogen bonding its applications, effects of these forces on melting point boiling point solubility.	15
2	**Transition Elements (3d series)**	

	Definition of transition Elements, General electronic configuration of transition elements, Classification of transition elements , Physico- chemical properties of transition elements with reference to electronic configuration, variable oxidation state (first and second transition series), Ionisation energy, complex formation, magnetic properties, catalytic properties, alloys formation and interstitial compound formation, Preparation, properties and uses of $KMnO_4$ and $K_2Cr_2O_7$. Structure of $K_2Cr_2O_7$ and $K_2 CrO_4$.	15
3	**Coordination chemistry** Double salt , Complex compounds, Difference between double salts and complex compounds, Types of complex compounds, Basic terminology of coordination chemistry (ligands, types of ligands, central metal ion, oxidation state, coordination number), Werners theory of complex compounds, IUPAC nomenclature of complex compounds (Mono nuclear complex), Factors affecting the stability of complex compounds, Isomerism in complex compounds, Applications of complex compounds in analytical chemistry, biological system and medicine. Bonding in complex compounds, Valence bond theory, EAN rule.	15
4	**Crystal Field Theory** Introduction, Crystal field effect, Crystal field splitting diagram for tetrahedral and octahedral complex. octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	James E. Huheey, “Inorganic Chemistry: Principles of structure and reactivity”, Prentice Hall, IV Edition.	
2	D. S. Shriver and P.A. Atkins, “Inorganic Chemistry”, Oxford University Press, IV Edition	

3	Alan G. Sharpe, “Inorganic Chemistry”, University of Cambridge, III Edition.	
4	J. D. Lee, “A New Concise Inorganic Chemistry”, ELBS IV Edition	
5	B. Douglas, D. H. McDaniel and J. J. Alexander, “Concepts and Models of Inorganic Chemistry”, John Wiley and Sons, III Edition	
6	Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.	

Course Code **BSCH 350CCP** **Semester- 3**

Course Title **Chemical Bonding, Transition Metals & Coordination Chemistry**

Scheme of Instruction		Scheme of Examination	
Total Duration	: 60Hr	Maximum Score	: 50
Periods /Week	: 4	Internal Evaluation	: 15
Credits	: 2	End Semester	: 35
Instruction Mode	: Lecture /Demonstration	Exam Duration	: 3 Hrs

Course Objectives: Preparation of standard solutions, standardization of secondary standards and the determination of desired constituent in a sample.

Course Outcomes: Abreast with different units of concentration of solution, standardization processs and application of redox reactions in chemical analysis.

Unit	Course Content	Instruction Hours
	List of Experiments: 1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared) 2. Determination of concentration of carbonate and bicarbonate present in a mixture. 3. Standardization of KMnO4 solution (standard solution of Mohr's salt to be prepared). 4. Determination of concentration of Fe(II) in Mohr's salt and/or K2Cr2O7 using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of K2Cr2O7 and /or Mohr's salt to be prepared). 5. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.	60Hrs

	6. Determination of iron content in ores / alloys using appropriate redox titration. 7. Determination of concentration of total hardness of a given sample of water by complexometric titration 8. Preparation of complex compounds i)Tetraamminecarbonatocobalt (III) ion ii) Potassium tris(oxalate)ferrate(III), iii) Tetraamminecopper (II) sulphate,	
Examination and Evaluation Pattern :		
Text Books and References :		
1	Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009	
2	Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.	
3	Harris, D.C. & Freeman, W.H. & Co. Quantitative Chemical Analysis 7th Ed., New York	

Course Code **BCH 401CCT** **Semester**

Course Title **Physical Chemistry for the Biosciences** **4**

Scheme of Instruction		Scheme of Examination	
Total Duration	: 60Hr	Maximum Score	: 100
Periods /Week	: 4	Internal Evaluation	: 30
Credits	: 4	End Semester	: 70
Instruction Mode	: Lecture	Exam Duration	: 3 Hrs

Course Objectives: Studies of thermal and kinetic aspects of chemical reactions.

Course Outcomes: Accumulation of knowledge about the roles of temperature, pH, reaction media and catalysis on the progress of chemical reactions.

Unit	Course Content	Instruction Hours
1	**Chemical Energetics** Laws of Thermodynamics, important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.	15
2	**Chemical and Ionic Equilibrium** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases. 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. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis of different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts.	15
3	**Chemical Kinetics**	

	Rate of reaction, Unit of rate of reaction, rate constant and specific rate constant, Rate law, Order of reaction, Differential and integrated form of rate expression up to second order reaction, Experimental methods of determination of rate laws, kinetics of complex reaction (integrated rate expression up to first order only), Molecularity of a reaction, Molecularity of a complex reaction. Temperature dependence of reaction rates, Arrhenius equation, Activation energy, Deferent methods of calculation of activation energy. Collision theory of reaction rate. Numerical problem based on activation energy.	15
4	**Surface Chemistry and Colloids** Adsorption, Absorption, Types of adsorption, Difference between physical and chemical adsorption, Factors affecting adsorption, adsorption isotherms, Freundlich and Langmuir adsorption isotherms, Applications of adsorption. Difference between collods and true solution. Classification of colloids on the basis of nature of dispersed phase and dispersion medium, on the basis of interaction between dispersed phase and dispersion medium, Methods of preparation of colloids by Chemical methods, Properties of colloids, Brownian movement, Tyndal effect, Electrophoresis, Gold number, Application of colloids, Emulsion, types of emulsion, Identification of emulsion, application of emulsion.	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 9th Ed., Oxford University Press (2011)	
2	Ball, D. W. Physical Chemistry Thomson Press, India (2007).	
3	Alan G. Sharpe, "Inorganic Chemistry", University of Cambridge, III Edition.	
4	Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).	
5	Chang, R. Physical Chemistry for the Biosciences. University Science Books (2005)Edition	

6	Puri & Sharma	

MANUU - Department of Chemistry School of Sciences

Course Code **BSCH 450CCP** **Semester**

Course Title **Physical Chemistry for the Biosciences** 4

Scheme of Instruction		Scheme of Examination	
Total Duration	: 60Hr	Maximum Score	: 50
Periods /Week	: 4	Internal Evaluation	: 15
Credits	: 2	End Semester	: 35
Instruction Mode	: Lecture /Demonstration	Exam Duration	: 3 Hrs

Course Objectives: Application of thermo analytical and electro analytical techniques in quantitative analysis.

Course Outcomes: Awareness about the utility of various physico- chemical, optical and chemical methods in chemical analysis.

Unit	Course Content	Instruction Hours
	List of Experiments: 1.Determination of heat capacity of a calorimeter for different volumes. 2. Determination of the enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Preparation of sodium acetate-acetic acid buffer solutions and measurement of their pH. 4. Potentiometric titrations of (i) strong acid vs strong base (ii) weak acid vs strong base 5. Determination of dissociation constant of a weak acid. 6. Integrated rate method: a. Acid hydrolysis of methyl acetate with hydrochloric acid. b. Saponification of ethyl acetate 7. Verification of Lambert-Beer's Law for potassium dichromate/ potassium permanganate solution. 8.Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.	60Hrs
Examination and Evaluation Pattern :		
Text Books and References :		

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

Course Code **BCH 502 DST** **Semester**

Course Title **Analytical Methods in Chemistry** **5**

Scheme of Instruction

Total Duration : 60Hr

Periods /Week : 4

Credits : 4

Instruction Mode : Lecture

Scheme of Examination

Maximum Score : 100

Internal Evaluation : 30

End Semester : 70

Exam Duration : 3 Hrs

Course Objectives:

To kindle confidence in students for better understanding of basic concepts of classical and modern analytical methods of chemical analysis as well as to keep abreast with developments of recent techniques of analysis.

Outcomes : The knowledge of fundamental principles of each analytical method of analysis with possible applications will induce great confidence among students to utilize different analytical techniques in chemical analysis.

Unit	Course Content	Instruction Hours
1	**Analytical Chemistry and Statistical Analysis of Analytical Data** Introduction and importance of analytical chemistry. Role of instrumentation in chemical analysis. Collection, arrangement and analysis of analytical data. Types and sources of errors of	15

	analytical data, determinate and indeterminate errors, absolute and relative errors. Normal (or Gaussian error cure), accuracy and precision, statistical terms (mean, median, median deviation, standard deviation and variance). criteria of validity or rejection of result. Numerical problems.	
2	**UV- Visisble spectrometry:** Interaction of radiation with matter and types of electron transitions. Chromophores and auxochrome groups. UV- Visible spectrometry : Validity of Beer- Lambert's law. Basic principles of instrumentation (choice of source, monochromator and detector) , Single and double beam instruments. Application in quantitative analysis, estimation of metal ions from aqueous solution, geometrical isomers, determination of composition of metal complexes using Job's method of continuous variation and mole ratio methods. Deviation from Beer,s law and photometric titrations.	15
3	**IR and atomic Absorption / Emission Techniques:** Infrared spectrometry; basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instruments, sampling techniques. Structural illustration through interpretation of data, effect of hydrogen bonding. Flame atomic absorption and emission spectrometry: principle and applications in quantitative estimation of trace level of metal ions from water samples. Sources of chemical interferences and their methods of removal.	15
4	**Separation Techniques :** Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion – exchange mechanism. Bonded phases and reversed phase chromatography. Qualitative and quantitative aspects of chromatographic methods (IEC, GLC, GPC and HPLC /	15

	HPTLC). Chromatographic parameters(capacity factor, separation factor and resolution). Applications of chromatography techniques in metal ion separation, deionization of water and analysis of polymers, pharmaceutical products, bimoleculess and stereoisomer's.	
Examination and Evaluation Pattern :		
Text Books and References :		
1	E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.	
2	R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.	
3	S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.	
4	A.K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.	
5	A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).	
6	S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.	

Course Code **BCH 601DST** **Semester**

Course Title **Bioinorganic & Environmental Chemistry** **6**

Scheme of Instruction		Scheme of Examination	
Total Duration	: 60Hr	Maximum Score	: 100
Periods /Week	: 4	Internal Evaluation	: 30
Credits	: 4	End Semester	: 70
Instruction Mode	: Lecture	Exam Duration	: 3 Hrs

Course Objectives: Impact of inorganic metal ions and air pollutants on environment and human health. Remedial steps for pollution control.

Course Outcomes: Better understanding about the composition of atmosphere, hydrosphere and biosphere. Awareness about the impact of inorganic ions on environment and human health. Concept of green chemistry in pollution control.

Unit	Course Content	Instruction Hours
1	**Bio-Inorganic Chemistry** A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).	15
2	**Environment and its segments** Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution SO_2, CO_2, CO, NOx, H_2S	15

	and other foul smelling gases. Methods of estimation of CO, NOx, SOx Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.	
3	**Water Pollution** Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.	15
4	**Energy & Environment** Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.	
2	R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.	
3	S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.	
4	A.K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.	
5	A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).	

6	S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.	

CourseCode **Semester**
BCH551DST

Course Title **Analytical Methods in Chemistry** 6

Scheme of Instruction
Total Duration : 60Hr
Periods /Week : 4
Credits : 2
Instruction Mode : Lecture /Demonstration

Scheme of Examination
Maximum Score : 50
Internal Evaluation : 15
End Semester : 35
Exam Duration : 3 Hrs

Course Objectives: To use of volumetric methods of analysis for determination of analytes of different types in water samples.

Course Outcomes: The students will understand the various steps involved in volumetric analysis and gain knowledge of deciding proper method for estimation of desired constituents in specific sample.

Unit	Course Content	Instruction Hours
	1. Determination of dissolved oxygen in water. 2. Determination of Chemical Oxygen Demand (COD) 3. Determination of Biological Oxygen Demand (BOD) 4. Percentage of available chlorine in bleaching powder 5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO3 and potassium chromate) 6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method 7. Measurement of dissolved CO_2. 8.Preparation of borax/ boric acid. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given).	60
Examination and Evaluation Pattern :		
Text Books and References :		
1	E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.	
2	R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.	
3	S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.	
4	A.K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.	
5	A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).	

6	S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.	