

## BSM 505: Inorganic Chemistry

Marks: 70

Time: 2 Hrs

### UNIT 1

#### **Metal-ligand Bonding in Transition Metal Complexes**

Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral complexes.

### UNIT 2

Crystal field splitting in tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

### UNIT 3

#### **Thermodynamic and Kinetic Aspects of Metal Complexes**

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes of Pt(II).

### UNIT 4

#### **Magnetic Properties of Transition Metal Complexes**

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling,  $\mu_{\text{eff}}$  values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

### UNIT 5

#### **Electron Spectra of Transition Metal Complexes**

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for  $d_1$  and  $d_9$  states, discussion of the electronic spectrum of  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  complex ion.

## **BSM 506: Organic Chemistry**

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**Time: 2 Hrs**

### **UNIT 1**

#### **NMR Spectroscopy-I**

Principle of nuclear magnetic resonance, the PMR spectrum, number of signals, peak areas, equivalent and non equivalent protons positions of signals and chemical shift, shielding and deshielding of protons, proton counting, splitting of signals and coupling constants, magnetic equivalence of protons..

### **UNIT 2**

#### **NMR Spectroscopy-II**

Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethane, 1,1,2-tribromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone..Simple problems on PMR spectroscopy for structure determination of organic compounds.

### **UNIT 3**

#### **Carbohydrates-I**

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+)-glucose & D(-) fructose. Mechanism of mutarotation. Structures of ribose and deoxyribose.

### **UNIT 4**

#### **Carbohydrates-II**

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

### **UNIT 5**

#### **Organometallic Compounds**

Organomagnesium compounds: the Grignard reagents-formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.

## **BSM 507: Physical Chemistry**

**Marks: 70**

**Time: 3 Hrs**

### **UNIT 1**

#### **Quantum Mechanics-I**

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Compton effect, wave function and its significance of Postulates of quantum mechanics, quantum mechanical operator, commutation relations, Hamiltonian operator, Hermitian operator,

### **UNIT 2**

average value of square of Hermitian as a positive quantity, Role of operators in quantum mechanics, To show quantum mechanically that position and momentum cannot be predicated simultaneously, Determination of wave function & energy of a particle in one dimensional box, Pictorial representation and its significance.

### **UNIT 3**

#### **Physical Properties and Molecular Structure**

Optical activity, polarization – (Clausius – Mossotti equation). Orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, Magnetic permeability, magnetic susceptibility and its determination. Application of magnetic susceptibility, magnetic properties – paramagnetism, diamagnetism and ferromagnetics.

### **UNIT 4**

#### **Spectroscopy-I**

**Introduction:** Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born-Oppenheimer approximation, Degrees of freedom.

**Rotational Spectrum:** Diatomic molecules. Energy levels of rigid rotator (semi-classical principles), selection rules, spectral intensity distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotor, isotope effect.

### **UNIT 5**

#### **Spectroscopy-II**

##### **Vibrational spectrum**

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effects of anharmonic motion and isotopic effect on the spectra., idea of vibrational frequencies of different functional groups.

### UNIT 1

#### Organometallic Chemistry

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, and bonding of alkyls of Li, Al, Hg, and Sn a brief account of metal-ethylenic complexes, mononuclear carbonyls and the nature of bonding in metal carbonyls.

### UNIT 2

#### Acids and Bases, HSAB Concept

Arrhenius, Bronsted – Lowry, the Lux – Flood, Solvent system and Lewis concepts of acids & bases, relative strength of acids & bases,

### UNIT 3

Concept of Hard and Soft Acids & Bases. Symbiosis, electronegativity and hardness and softness

### UNIT 4

#### Bioinorganic Chemistry

Essential and trace elements in biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to  $\text{Ca}^{2+}$ . Nitrogen fixation.

### UNIT 5

#### Silicones and Phosphazenes

Silicones and phosphazenes, their preparation, properties, structure and uses

## **BSM 606: Organic Chemistry**

Max. Marks : 70

Time : 2 Hrs

### **UNIT 1**

#### **Heterocyclic Compounds-I**

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole

### **UNIT 2**

#### **Heterocyclic Compounds-II**

Introduction to condensed five and six- membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of, quinoline and isoquinoline

### **UNIT 3**

#### **Organosulphur Compounds**

Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine. Synthetic detergents alkyl and aryl sulphonates.

### **UNIT 4**

#### **Organic Synthesis via Enolates**

Acidity of hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.

#### **Synthetic Polymers**

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.

### **UNIT 5**

#### **Amino Acids, Peptides & Proteins**

Classification, of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation of  $\alpha$ -amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins: Primary & Secondary structure.

## **BSM 607: Physical Chemistry**

Max. Marks : 70

Time : 3 Hrs

### **UNIT 1**

#### **Spectroscopy-III Electronic Spectrum**

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck- Condon principle. Qualitative description of sigma and pie and n molecular orbital (MO) their energy level and respective transitions.

### **UNIT 2**

#### **Photochemistry**

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law (law of photochemical equivalence) Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

### **UNIT 3**

#### **Solutions:**

##### **Dilute Solutions and Colligative Properties**

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, Colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point,

### **UNIT 4**

Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

### **UNIT 5**

#### **Phase Equilibrium**

Statement and meaning of the terms – phase component and degree of freedom, thermodynamic derivation of Gibbs phase rule, phase equilibria of one component system –Example – water and Sulphur systems. Phase

## BSM 509: Chemistry Practical

Max. Marks : 50

Time : 1 Hrs.

### SECTION – I (Inorganic)

Semimicro qualitative analysis of mixture containing not more than four radicals (including interfering, Combinations and excluding insolubles):

$Pb^{2+}$ ,  $Hg^{2+}$ ,  $Hg_2^{2+}$ ,  $Ag^+$ ,  $Bi^{3+}$ ,  $Cu^{2+}$ ,  $Cd^{2+}$ ,  $As^{3+}$ ,  $Sb^{3+}$ ,  $Sn^{2+}$ ,  $Fe^{3+}$ ,  $Cr^{3+}$ ,  $Al^{3+}$ ,  $Co^{2+}$ ,  $Ni^{2+}$ ,  $Mn^{2+}$ ,  $Zn^{2+}$ ,  $Ba^{2+}$ ,  $Sr^{2+}$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ ,  $NH_4^+$ ,  $CO_3^{2-}$ ,  $S^{2-}$ ,  $SO_3^{2-}$ ,  $S_2O_3^{2-}$ ,  $NO_2^-$ ,  $CH_3COO^-$ ,  $Cl^-$ ,  $Br^-$ ,  $I^-$ ,  $NO_3^-$ ,  $SO_4^{2-}$ ,  $C_2O_4^{2-}$ ,  $PO_4^{3-}$ ,  $BO_3^{3-}$ .

#### Section-B (Physical)

1. To determine the strength of the given acid solution (mono and dibasic acid) conductometrically.
2. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically
3. To determine the strength of given acid solution (mono and dibasic acid)/ $KMnO_4$  – Mohr salt potentiometrically.
4. To determine the molecular weight of a non-volatile solute by Rast method.
5. To standardize the given acid solution (mono and dibasic acid) pH metrically.

### Section-C (Organic)

#### 1. Laboratory Techniques

(a) **Steam distillation** (non evaluative)

Naphthalene from its suspension in water

Separation of *o*- and *p*-nitrophenols

(b) **Column chromatography** (non evaluative)

Separation of fluorescein and methylene blue

Separation of leaf pigments from spinach leaves

#### 2. Chromatography Method

Determination of  $R_f$  values and identification of organic compounds

(a) Separation of green leaf pigments (spinach leaves may be used) by paper chromatographic method

(b) Separation of a mixture of coloured organic compounds using common organic solvents by TLC.

#### 3. Synthesis of the following organic compounds:

(a) To prepare *o*-chlorobenzoic acid from anthranilic acid.

(b) To prepare *p*-bromoaniline from *p*-bromoacetanilide.

(c) To prepare *m*-nitroaniline from *m*-dinitrobenzene.

(d) To prepare *S*-Benzyl-iso-thiourea chloride from thiourea.