JAI HIND COLLEGE AUTONOMOUS

Syllabus for F.Y.BSc

Course : Chemistry

Semester : II

Credit Based Semester & Grading System

With effect from Academic Year 2018-19
## List of Courses

Course: Chemistry | Semester: II

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>NO. OF LECTURES / WEEK</th>
<th>NO. OF CREDITS</th>
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<td><strong>FYBSc</strong></td>
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<td><strong>Semester II</strong></td>
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<tr>
<td>1</td>
<td>SCHE201</td>
<td>Concepts of Physical and Inorganic Chemistry - II</td>
<td>3</td>
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<td>2</td>
<td>SCHE202</td>
<td>Concepts of Organic and Co-ordination Chemistry</td>
<td>3</td>
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<td>3</td>
<td>SCHE2PR</td>
<td>Practical Course work in Chemistry - I</td>
<td>6</td>
<td>2</td>
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**Semester II – Theory**

| Course: SCHE201 | Concepts of Physical and Inorganic Chemistry - II (Credits: 2) Lectures/Week: 3)  
**Course description:** States of Matter, Ionic Equilibria, Chemical Bonding and Molecular Structure  
**Objectives:**  
- To understand the theoretical principles of the states of matter, their properties and various applications  
- To understand the concept of ionic equilibria, pH, theory of ionic products, theory of acids and bases, theory of indicators, solubility product & their practical applications  
- To understand the importance of the Periodic Table of elements, historical perspective, and role in organization of chemical information  
- To create and label models of atoms, writing and balancing of chemical equations  |

<table>
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<tr>
<th><strong>Unit I</strong></th>
<th><strong>Unit II: Ionic Equilibria</strong></th>
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</thead>
</table>
| **Gaseous state**  
i. Ideal gas behaviour and kinetic theory of gases (only postulates)  
ii. Distribution of molecular speed (Maxwell Boltzmann’s plot)  
iii. Real gases: Compressibility factor, Boyle’s temperature, van der Waal’s equation of state  
iv. Liquefaction of gases (Numerical expected)  | **Strong, moderate and weak electrolytes:**  
i. Ionization constant and ionic product of water  
ii. pH scale  
iii. Common ion effect  
iv. Dissociation constant of mono-, di- and tri-protic acid  
v. Buffer solution, buffer capacity and buffer action  
vi. Henderson’s equation for acidic and basic buffer  
vii. Applications of buffer in biochemical processes  |
| **Liquid state**  
i. Introduction  
ii. Liquid-vapour equilibrium (vapour pressure)  
iii. Surface tension: determination using stalgmometer, effect of temperature on surface tension, parachor and its applications  
iv. Viscosity: measurement using Ostwald’s viscometer, effect of temperature on viscosity  
v. Refractive index: molar refraction and polarizability, determination using Abbe’s refractometer  
vi. Liquid crystals: Introduction, classification and applications (Numerical expected)  |  |
| b) Hydrolysis of salts  
  i. Hydrolysis constant, degree of hydrolysis |
| c) Theory of acid-base indicators  
  Action of phenolphthalein and methyl orange |
| d) Solubility and solubility product of sparingly soluble salts  
  i. Applications of principles of solubility product |
| e) Ionic equilibria involving complex ions  
  (Numerical expected) |

| Unit III: Chemical Bonding and Molecular Structure |
| a) Chemical bond  
  i. Introduction  
  ii. Octet rule |
| a) Ionic Bonding  
  i. General characteristics of ionic bonding  
  ii. Energy considerations in ionic bonding; lattice and solvation energy and their importance in the context of stability and solubility of ionic compounds  
  iii. Statement of Born-Landé equation for calculation of lattice energy  
  iv. Born-Haber cycle and its applications  
  v. Polarizing power and polarizability  
  vi. Fajan’s rules, ionic character in covalent compounds,  
  vii. Bond moment, dipole moment and percentage ionic character |
| c) Covalent bonding  
  i. VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.  
  ii. Concept of resonance and resonating structures in various inorganic and organic compounds |

References:

**Unit 1 & 2**

4. Glasston & Lewis, *Principles of Physical Chemistry*

**Unit 3**

<table>
<thead>
<tr>
<th>Course: SCHE202</th>
<th>Concepts of Organic and Coordination Chemistry (Credits: 2 Lectures/Week: 3)</th>
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<tbody>
<tr>
<td><strong>Course description:</strong></td>
<td>Reactive Intermediates, Aromaticity, Orientation effect in electrophilic aromatic substitution, Basic concepts of Coordination Chemistry and compounds of transition metal elements</td>
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<tr>
<td><strong>Objectives:</strong></td>
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<tr>
<td>➢ To list different reactive intermediates and reason their relative stabilities</td>
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<tr>
<td>➢ To define the parameters required for aromaticity</td>
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<td>➢ To propose the orienting influence of a group in electrophilic aromatic substitution based on electron density</td>
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<td>➢ To relate the methods of preparation and reactions of unsaturated aliphatic hydrocarbons and oxygenated derivatives of aliphatic and aromatic systems</td>
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<td>➢ To discuss the chemistry of formation of transition metal compounds; an introduction to coordination chemistry and to understand the salient features of coordination compounds</td>
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<thead>
<tr>
<th>Unit I</th>
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<tbody>
<tr>
<td><strong>Unit – I: Reactive Intermediates &amp; reactivity of aromatic compounds</strong></td>
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<tr>
<td>1. General Organic Chemistry – II</td>
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<tr>
<td>a) Reactive Intermediates: structure shape &amp; relative stability</td>
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<tr>
<td>i. Carbocations</td>
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<td>ii. Carbanions</td>
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<td>iii. Free radicals</td>
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<td>iv. Carbenes</td>
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<td>b) Reactivity of organic molecules</td>
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<tr>
<td>i. Nucleophiles &amp; basicity</td>
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<td>ii. Electrophiles &amp; Acidity</td>
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<td>c) Reactions involving Intermediates</td>
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<tr>
<td>i. Carbocations- Acid catalysed hydration of alkenes, Friedel-Crafts alkylation reaction</td>
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<td>ii. Carbanions- homologation of terminal alkynes;</td>
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<td>iii. Free radical- Halogenation of alkane, selectivity rules</td>
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<td>(Mechanism expected)</td>
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<td>2. Chemistry of Aromatic Compounds- I</td>
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<tr>
<td>a) Aromaticity</td>
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<tr>
<td>i. Conditions of aromaticity</td>
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<td>ii. Huckel's Rule</td>
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<td>iii. Aromaticity of arenes &amp; arenum ions</td>
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<td>b) Electrophilic Aromatic Substitution</td>
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<tr>
<td>i. ESR- nitration, sulphonation, halogenation (w.r.t. reagents &amp; reaction conditions)</td>
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<td>ii. Activating, deactivating groups</td>
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<td>iii. Orientation effect (mono &amp; disubstituted) based on electron density</td>
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### Unit II: Unsaturated aliphatic hydrocarbons & compounds containing oxygen - I

#### 1. Chemistry of unsaturated aliphatic hydrocarbons

**a) Alkenes**

i. Preparation - dehydration of alcohols & dehydrohalogenation of alkyl halides (Saytzeff rule)

ii. Reactions: cis-addition (alkaline KMnO$_4$, OsO$_4$) trans-addition (bromine, ring opening of epoxides); addition of HX (Markownikoff's & anti-Markownikoff's addition), hydration, ozonolysis, oxymercuration-demercuration, hydroboration-oxidation

**b) Alkynes**

i. Preparation - acetylene from CaC$_2$ (applications in fruit ripening); by dehalogenation of tetra halides & dehydrohalogenation of vicinal dihalides

ii. Reactions: hydration, addition of bromine & alkaline KMnO$_4$, ozonolysis & oxidation

#### 2. Chemistry of alcohols, phenols & ethers

**a) Alcohols**

i. Preparation - Industrial preparation (fermentation), using Grignard reagent, using hydride reducing agents

ii. Reactions - with sodium, HX (Lucas test), esterification, oxidation

**b) Phenols**

i. Preparation - Cumene hydroperoxide method

ii. Reactions - O-alkylation & O-acylation; Schotten Baumen reaction, Fries rearrangement, Claisen rearrangement

**c) Ethers**

i. Preparation - Williamson's synthesis

ii. Reactions - cleavage of ethers with HI

iii. Uses - ethers as solvents (THF, diethyl ether) in organic synthesis

### Unit III: Comparative chemistry of p-block & transition elements; Co-ordination chemistry

#### 1. Comparative chemistry of p-block elements

**a) Group 13 elements**

i. Trends in periodic properties

ii. Inert pair effect

iii. Chemistry of aluminium compounds: halides, oxides and alkyls

**b) Group 14 elements**

i. Trends in periodic properties

ii. Catenation

iii. Allotropy
iv. Uses and applications

2. Chemistry of Transition Elements (3d series)
   i. General group trends with special reference to electronic configuration
   ii. Variable valency & Colour
   iii. Magnetic and Catalytic property
   iv. Ability to form complexes and Stability of various oxidation states (Latimer diagrams) for Mn, Fe & Cu

3. Coordination Chemistry
   a) Introduction & nomenclature
      i. Basic terms
      ii. Nomenclature of Coordination compounds
      iii. Types of ligands
      iv. Evidence for the formation of coordination compounds
   b) Theories of Coordination Chemistry
      i. Werner theory and EAN rule
      ii. Structural and stereo isomerism of complexes with 4 & 6 coordination numbers
      iii. Valence Bond Theory (VBT) approach
      iv. Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6)
      v. Electro-neutrality principle and back bonding
      vi. Limitations of VBT

References:

Unit 1 & 2


Unit 3

Semester II – Practical

<table>
<thead>
<tr>
<th>Course: SCHE2PR</th>
<th>Practical Course work in Chemistry-II (Credits: 2 Practicals/Week: 2)</th>
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<tr>
<td></td>
<td><strong>Course description:</strong></td>
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<tr>
<td></td>
<td>Viscosity, Surface tension, Ionic Equilibria, Indicators, Gravimetric Analysis, Preparation of Inorganic Complexes, Basics of Identification of Organic Compounds, One-Step Synthesis, Chromatography</td>
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<td><strong>Learning Objectives:</strong></td>
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<td>➢ To develop the skill of observation, understanding and analysis of data</td>
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<td>➢ To apply the concept of indicators in determining the pH and strengths of solutions</td>
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<td>➢ To perform the quantitative preparation of coordination complexes with different types of ligands</td>
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<td>➢ To apply the concept of gravimetric analysis in determining the percentage purity of a sample</td>
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<td>➢ To perform preliminary investigations including solubility profile and element detection of mono-functional organic compounds</td>
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<td>➢ To develop the skills for one-step synthesis of organic compounds</td>
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**PRACTICAL – I**

A. **Viscosity**
   To determine the viscosity of aqueous solutions at room temperature using Ostwald’s Viscometer: (any 2)
   i. Polymer
   ii. Ethanol
   iii. Sugar

B. **Surface tension (Demonstrative experiment)**
   To determine the surface tension of a given liquid using stalagmometer

C. **Ionic Equilibria**
   To determine the pH of various concentrations of sodium acetate and acetic acid buffer solutions

**PRACTICAL – II**

A. **Gravimetric analysis**
   a) To determine the percentage purity of a sample of barium sulphate, containing ammonium chloride as impurity.
   b) To estimate the amount of sodium carbonate & bicarbonate in a mixture gravimetrically.

B. **Preparation of inorganic complexes (any two)**
   a) Tetraamine copper (II) sulphate
   b) Nickel DMG
   c) Potassium trioxalato ferrate(II)
PRACTICAL – III

A. Basics of Identification of Organic compounds
   a) To determine the solubility profile and elements (N, S, X) present in a given organic compound.

B. One-step synthesis
   a) Comparative analysis of the procedure of nitration reaction on different substrates:
      i. Nitration of nitrobenzene
      ii. Nitration of acetanilide

C. Chromatography (Demonstrative experiment)
   a) Paper chromatography
   b) Thin layer chromatography of ortho- and para-nitrophenol
Evaluation Scheme

A. Evaluation scheme for Theory courses
   I. Continuous Assessment (C.A.) - 40 Marks
      (i) C.A.-I : Test – 20 Marks of 40 mins. duration
      (ii) C.A.-II : Assignment/ Poster for 20 marks
   
   II. Semester End Examination (SEE)- 60 Marks

B. Evaluation scheme for Practical courses
   I. Internal Assessment - 40 Marks: Journal/Viva/Experiment Scheme
   
   II. Semester End Examination (SEE)- 60 Marks