CHEMISTRY, PRACTICAL BASED COURSE, Distribution of Marks [OUT OF 75] is as follows:

<table>
<thead>
<tr>
<th>EXAMINATION</th>
<th>Practical Based Course</th>
<th>Duration of Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEMESTER END Examination (THEORETICAL)</td>
<td>40</td>
<td>2 Hours</td>
</tr>
<tr>
<td>SEMESTER END Examination (PRACTICAL)</td>
<td>20</td>
<td>Upto 5 Hours</td>
</tr>
<tr>
<td>Continuous Evaluation/Internal Examination/Mid Semester Examination (TO BE CONDUCTED BY COLLEGES)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>ATTENDANCE</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>75</td>
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1. Distribution of 40 Marks for SEMESTER END THEORETICAL EXAMINATION

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Questions to be answered</th>
<th>Out of</th>
<th>Marks of each question</th>
<th>Total Marks</th>
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<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>5x1=5</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>3x5=15</td>
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<td>2</td>
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<td>2x10=20</td>
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</table>

However, questions carrying 5 or 10 Marks, need not necessarily to be a single question.

2. Distribution of 20 Marks for SEMESTER END PRACTICAL EXAMINATION

<table>
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<th>SL. No.</th>
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<tr>
<td>1</td>
<td>Lab. Note Book</td>
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<tr>
<td>2</td>
<td>Viva-voce</td>
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<tr>
<td>3</td>
<td>Experiment</td>
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<td>TOTAL</td>
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</table>

3. Continuous Evaluation/ Internal Assessment/ Mid Semester Examination: 10 Marks

Students should complete internal assessment before appearing at the respective Semester examination. All the internal continuing evaluation will be conducted by the teachers of the department. It shall be on the basis of dissertations/projects, term papers, reports, seminar presentation, class test or any combinations thereof spread over the entire period of study.

4. ATTENDANCE

<table>
<thead>
<tr>
<th>SL. No.</th>
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<tr>
<td>75% and above but below 80%</td>
<td>2 Marks</td>
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<tr>
<td>80% and above but below 85%</td>
<td>3 Marks</td>
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<tr>
<td>85% and above but below 90%</td>
<td>4 Marks</td>
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<tr>
<td>90% and Above</td>
<td>5 Marks</td>
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</table>

5. ELIGIBILITY FOR APPEARING AT ANY OF THE SEMESTERS EXAM.: A Candidate to be eligible for appearing at any of the Semesters must have a
minimum 75% attendance of the Lectures Delivered
CHOICE BASED CREDIT SYSTEM

BSc PROGRAM

With CHEMISTRY

UNIVERSITY OF NORTH BENGAL
## COURSE STRUCTURE [ BSc PROGRAM ]

<table>
<thead>
<tr>
<th>COURSE COMPONENTS</th>
<th>Number of Courses</th>
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<tbody>
<tr>
<td>DISCIPLINE SPECIFIC COURSE [DSC]</td>
<td>12</td>
</tr>
<tr>
<td>DISCIPLINE SPECIFIC ELECTIVE [DSE]</td>
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<tr>
<td>ABILITY ENHANCEMENT COMPULSORY COURSE [AECC]</td>
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<tr>
<td>SKILL ENHANCEMENT COURSE [SEC]</td>
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<td><strong>TOTAL</strong></td>
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## CREDIT DETAILS OF THE COURSE  BSc  PROGRAM

<table>
<thead>
<tr>
<th>SL.No.</th>
<th>COURSES</th>
<th>CREDIT</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>Theory+ Practical</td>
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<tr>
<td>1.</td>
<td>DSC (12 courses)</td>
<td>(12x4)+(12x2)</td>
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<tr>
<td>2.</td>
<td>DSE (6 Courses)</td>
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<tr>
<td>3.A.</td>
<td>AECC-1 (ENVS)</td>
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</tr>
<tr>
<td>3.B.</td>
<td>AECC-2 (Eng/MIL)</td>
<td>(2x1)</td>
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<tr>
<td>3.C.</td>
<td>SEC (4 Courses)</td>
<td>(4x2)</td>
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</tr>
<tr>
<td><strong>TOTAL CREDIT</strong></td>
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<tr>
<td><strong>TOTAL MARKS</strong></td>
<td></td>
<td><strong>1800</strong></td>
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Chemistry  (Credit: 06 each)

DSC: PAPER –I ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Section A: Inorganic Chemistry-1 (30 Periods)


What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of $\psi$ and $\psi^2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations. (14 Lectures)

Chemical Bonding and Molecular Structure

Ionic Bonding:

General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan’s rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding:

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. Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of
homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

(16 Lectures)

Section B: Organic Chemistry-1 (30 Periods)

Fundamentals of Organic Chemistry


Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel’s rule. (8 Lectures)

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems). (10 Lectures)

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.


Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff’s rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff’s and anti-Markownikoff’s addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4. (12 Lectures)
Reference Books:

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


  * Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.


---------------------------------------------------------------------------------------------------------------------
Section A: Inorganic Chemistry - Volumetric Analysis  (ANY THREE)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO4.
3. Estimation of water of crystallization in Mohr’s salt by titrating with KMnO4.
4. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.

Section B: Organic Chemistry  (ANY THREE)

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

* Svehla, G. Vogel’s Qualitative Inorganic Analysis, Pearson Education, 2012

* Mendham, J. Vogel’s Quantitative Chemical Analysis, Pearson, 2009

* Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J & Smith, P.W.G.,


CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Section A: Physical Chemistry-1 (30 Lectures)

Chemical Energetics


**Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between $\Delta G$ and $\Delta G^0$, Le Chatelier’s principle. Relationships between $K_p$, $K_c$ and $K_x$ for reactions involving ideal gases. (8 Lectures)

**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. 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. (12 Lectures)

Section B: Organic Chemistry-2 (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Aromatic hydrocarbons** Preparation (Case benzene): from phenol, by decarboxylation, 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). (8 Lectures)

**Alkyl and Aryl Halides**

**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols.

**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.

(8 Lectures)

**Alcohols, Phenols and Ethers (Upto 5 Carbons)**

**Alcohols**: Preparation: Preparation of 1о, 2о and 3о alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.


**Ethers** (aliphatic and aromatic): Cleavage of ethers with HI.

**Aldehydes and ketones** (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

**Reference Books:**


* Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.


*A Bhal, BS Bhal & GD Tuli, Essentials of Physical Chemistry, S. Chand, 2010.
DSC LAB: PAPER -2

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I 60 Lectures

Section A: Physical Chemistry

Thermochemistry (ANY TWO)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria [ pH measurements ]

Measurement of pH of different solutions like aerated drinks/ fruit juices/shampoos/ soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

a) Preparation of buffer solutions: (ANY ONE)
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(ANY ONE)

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
Reference Books


DSC : PAPER -3

SOLUTIONS, PHASE EQUILIBRIA, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP
ORGANIC CHEMISTRY-II

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Section A: Physical Chemistry-2 (30 Lectures)

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult’s law, deviations from Raoult’s law –
non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-
solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle
of steam distillation. Nernst distribution law and its applications, solvent extraction. (8 Lectures)

Phase Equilibria

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, FeCl3-H2O and Na-K
only). (8 Lectures)

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong
electrolytes. Kohlrausch law of independent migration of ions. Transference number and its
experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of
conductance measurements: determination of degree of ionization of weak electrolyte, solubility and
solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt.
Conductometric titrations (only acidbase). (6 Lectures)

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst
Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF
data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and
without transference. Liquid junction potential and salt bridge. pH determination using hydrogen
electrode and quinhydrone electrode. Potentiometric titrations - qualitative treatment (acid-base and
oxidation-reduction only). (8 Lectures)

Section B: Organic Chemistry-3 (30 Lectures)
Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Carboxylic acids and their derivatives** Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction.

**Carboxylic acid derivatives (aliphatic):** (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation. (6 Lectures)


**Diazonium salts:** Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes. (6 Lectures)


**Carbohydrates:** Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation. (8 Lectures)
Reference Books:


DSC LAB: PAPER -3
A: Physical Chemistry

Distribution (ANY ONE)

Study of the equilibrium of one of the following reactions by the distribution method:

\[ \text{I}_2(\text{aq}) + \text{I}^- (\text{aq}) \rightarrow \text{I}_3^- (\text{aq}) \]

\[ \text{Cu}^{2+}(\text{aq}) + x\text{NH}_2(\text{aq}) \rightarrow [\text{Cu(NH}_3)x]^{2+} \]

Phase equilibria (Any TWO)

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.

b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.

c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance

Perform the following conductometric titrations:

a. Strong acid vs. strong base

b. Weak acid vs. strong base

Potentiometry (ANY TWO)

1. Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry
I. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative

II. (ANY THREE)

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

Reference Books:


TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Section A: Inorganic Chemistry-2 (30 Lectures)

Transition Elements (3d series)

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 configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). (12 Lectures)

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. (8 Lectures)

Crystal Field Theory  Crystal field effect, 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. Jahn-Teller distortion, Square planar coordination. (10 Lectures)

Section B: Physical Chemistry-3 (30 Lectures)

Gases

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). (8 Lectures)

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). (6 Lectures)
Solids


Chemical Kinetics


Reference Books:

* Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley
* Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd
DSC LAB: PAPER -4

TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

60 Lectures

Section A: Inorganic Chemistry

a) Semi-micro qualitative analysis (using H2S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following:

Cations : NH4 +, Pb2+, Bi3+, Cu2+, Cd2+, Fe3+, Al3+, Co2+, Ni2+, Mn2+, Zn2+, Ba2+, Sr2+, Ca2+, K+
Anions : CO3 2−, S2−, SO2−, S2O3 2−, NO3 −, CH3COO− , Cl−, Br−, I−, NO3 −, SO4 2−, PO4 3−, BO3 3−, C2O4 2−, F− (Spot tests should be carried out wherever feasible)

b) (ANY TWO)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.

2. Estimation of (i) Mg2+ or (ii) Zn2+ by complexometric titrations using EDTA.

3. Estimation of total hardness of a given sample of water by complexometric titration.

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded). (ANY ONE)

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

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded). (ANY ONE)

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald’s viscometer.

b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

Integrated rate method: (ANY ONE)

a) Acid hydrolysis of methyl acetate with hydrochloric acid

b). Saponification of ethyl acetate.
Reference Books:


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

CHEMISTRY
DSE: PAPER-2
POLYMER CHEMISTRY

(Credits: Theory-06, Practicals-02)

Theory: 60 Lectures

Introduction and history of polymeric materials:
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Classifications including di-,tri-, and amphiphilic polymers.

(2 Lectures)

Functionality and its importance: Addition and Condensation – Mechanism of Cationic, anionic and free radical addition polymerization.

(10 Lectures)


(10 Lectures)

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. Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

(6 Lectures)

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

(4 Lectures)
Nature and structure of polymers - Structure Property relationships.

(2 Lectures)

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.

(8 Lectures)

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

(6 Lectures)

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.

(6 Lectures)

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

Brief introduction to preparation, structure, properties and application of the following polymers: polylefins, 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)].

(10 Lectures)

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.

(6 Lectures)

Reference Books:

DSE LAB: PAPER-2

POLYMER CHEMISTRY

60 Lectures

1. Polymer synthesis (Any Three)

   1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
      a. Purification of monomer
      b. Polymerization using benzoyl peroxide (BPO) / 2,2’-azo-bis-isobutylonitrile (AIBN)

   2. Preparation of nylon 66/6

   3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
      a. Preparation of IPC
      b. Purification of IPC
      c. Interfacial polymerization

4. Redox polymerization of acrylamide
5. Precipitation polymerization of acrylonitrile
6. Preparation of urea-formaldehyde resin
7. Preparations of novalac resin/ resold resin.
8. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization (Any Two)

1. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq.NaNO₂ solution
   (b) (Poly vinyl propyldiene (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).
5. Determination of hydroxyl number of a polymer using colorimetric method.
Polymer analysis (Any Two)

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

Reference Books:

DSE: PAPER-1

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

(16 Lectures)

Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

(8 Lectures)

Surface Coatings:

(Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

(10 Lectures)
Batteries:
Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

(6 Lectures)

Alloys:
Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

(10 Lectures)

Catalysis:
General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

(6 Lectures)

Chemical explosives:
Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

(4 Lectures)

Reference Books:
DSE LAB: PAPER-1

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

60 Lectures

(Any Five)

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn ) in alloy or synthetic samples.
8. Preparation of pigment (zinc oxide).

Reference Books:


GREEN METHODS IN CHEMISTRY

Theory: 30 Lectures

Theory and Hand-on Experiments

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability

The following Real world Cases in Green Chemistry should be discussed:

- Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments.
- Designing of environmentally safe marine antifoulant.
- Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

Practicals

- Preparation and characterization of biodiesel from vegetable oil.
- Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.
- Mechano chemical solvent free synthesis of azomethine.
- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).

Reference Books:

PHARMACEUTICAL CHEMISTRY

(Credits: 02)

Theory: 30 Lectures

Drugs & Pharmaceuticals

Classification, Structure and drug discovery, design and development and therapeutic uses; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); Antimalarials: Chloroquine (with synthesis). antibiotics (detailed study of Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Practicals (any two)

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).
3. Any other preparation as desired.

Reference Books:

## Scheme for CBCS in BSc Program

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SEMESTER</th>
<th>DISCIPLINE SPECIFIC CORE COURSE [DSC]</th>
<th>ABILITY ENHANCEMENT COMPULSORY COURSE [AECC]</th>
<th>SKILL ENHANCEMENT COURSE [SEC]</th>
<th>DISCIPLINE SPECIFIC ELECTIVE COURSE [DSE]</th>
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*Note:* DSE-I will be the same subject as DSC-I

DSE-2 will be the same subject as DSC-2

DSE-3 will be the same subject as DSC-3

*SEC-1 and SEC-2 can be chosen from any of the THREE [3] DSC Subjects taken above.
SCHEME for BSc PROGRAM [With **CHEMISTRY** as one of the Three DSC (DISCIPLINE SPECIFIC CORE COURSES)]

**SEMESTER I and 2**

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**TOTAL CREDIT** 120
**TOTAL MARKS** 1800
SYLLABUS FOR CBCS IN BSc PROGRAM

[WITH CHEMISTRY AS ONE OF THE DSC SUBJECTS CHOSEN]

**DISCIPLINE SPECIFIC CORE** [DSC- I/2/3] [CREDIT: 6 Each Paper]

<table>
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<tr>
<th>DSC-I/2/3</th>
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<th>Atomic Structure, Bonding, Organic Chemistry &amp; Aliphatic Hydrocarbons</th>
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**DISCIPLINE SPECIFIC ELECTIVE** [DSE -1/2/3] [ CREDIT: 6 of Each Paper]

| DSE -1/2/3 | PAPER-1 | Inorganic materials of Industrial Importance |
|            | PAPER-2 | Polymer chemistry |

**SKILL ENHANCEMENT COURSE** [SEC -1/ 2] [Credit: 2 of Each paper]

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