TRIPURA UNIVERSITY
SURYAMANINAGAR
SYLLABUS FOR B.Sc THREE-YEAR DEGREE (GENERAL AND HONOURS) COURSE
UNDER 1+1+1 SYSTEM OF EXAMINATION
(WITH EFFECT FROM 2008)
SUBJECT: CHEMISTRY
COURSE STRUCTURE WITH DISTRIBUTION OF MARKS FOR B.Sc HONOURS EXAMINATION
TOTAL MARKS: 1550; DURATION: 3YEARS

Part-I Examination (at the end of 1st year)	**Part-II examination** (at the end of 2nd year)	**Part-III Examination** (at the end of 3rd year)
a)Chemistry Honours Papers-Two Paper-I (Theoretical) : 100 Marks Paper-IIA(Theoretical): 50 Marks Paper-IIB (Practical): 50 Marks b)Elective Subjects – Two 1st Elective Subject : Paper –I (Theoretical) : 100 Marks 2nd Elective Subject : Paper-1 (Theoretical) : 100 Marks c)Language Group Paper-1 (Theoretical) : 100 Marks	a) Chemistry Honours Papers-Two Paper-III (Theoretical) :100 Marks Paper-IVA(Theoretical): 50 Marks Paper-IVB(Practical): 50 Marks b)Elective Subjects- Two 1st Elective Subject : Paper-II(Theoretical) : 100 Marks Paper-III(Practical) : 100Marks 2nd Elective Subject : Paper-II(Theoretical):100 Marks Paper-III(Theoretical/ Practical) : 100 Marks c)Language Group- Nil	a)Chemistry Honours Papers -Four Paper-V (Theoretical) : 100 Marks Paper-VI (Theoretical):100 Marks Paper-VII(Practical) : 100 Marks Paper-VIII(Practical) : 100 Marks b)Elective Subject- Nil c)Environmental Studies Paper-I : 50 Marks
Total Marks : 500	**: 600**	**: 450**

COURSE STRUCTURE WITH DISTRIBUTION OF MARKS FOR B.Sc
GENERAL EXAMINATION
TOTAL MARKS: 1350
DURATION: 3 YEARS

Part-I Examination (at the end of 1st year)	**Part-II Examination** (at the end of 2nd year)	**Part-III Examination** (at the end of 3rd year)
a) Elective Subjects: Three For each Elective Subject: Paper-I(Theoretical): 100 Marks b) Language Group Paper-I (Theoretical) : 100 Marks Group A(English) : 50 Marks Group B(Bengali/Hindi/ Kokbarak) : 30 Marks Group C (Indian Heritage & Culture) : 20 Marks	a) Elective subjects: Three 1st Elective Subject : Paper-II(Theoretical) : 100 Marks Paper-III(Practical) : 100 Marks 2nd Elective Subject : Paper-II(Theoretical) : 100 Marks Paper-III(Practical) : 100 Marks 3rd Elective Subject : Paper-II(Theoretical):100 Marks Paper-III(Theoretical/ Practical) : 100 Marks b) Language Group- Nil	a) Elective Subjects: Three 1st Elective Subject: Paper IVA(Theoretical): 70 Marks Paper IVB(Practical) : 30 Marks 2nd Elective Subject: Paper IVA(Theoretical): 70 Marks Paper IVB(Practical) : 30 Marks 3rd Elective Subject: Paper IV(Theoretical) :100 Marks b) Environmental studies: Paper-I: 50 Marks
Total Marks : 400	**: 600**	**:350**

B.Sc Chemistry (Honours) Part-I Syallabus
Paper-IA (Organic Chemistry): 50 Marks
Total Units: Three

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.

b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT-I : Structure and bonding of Organic Compounds and mechanism of Organic reactions.

(a) **General Introduction**: Organic compounds and their classification , nomenclature (trivial and IUPAC) , molecular formula, DBE, idea of framing constitution from molecular formula.

(b) **Bonding Features**: Nature of bonds and its orbital representation , atomic and molecular orbitals - bonding, nonbonding and anti-bonding, hybridization(sp^n ,n= 1,2,3) of C,N,O, halogens, bond lengths , bond angles , bond energy , bond polarity , bond polarizability, formation of σ and π bonds, localized and delocalized chemical bonds , van der Waals interaction , conjugation(resonance) , resonance energy, steric inhibition of resonance, hyperconjugation , inductive and field effects , H-bonding , dipole moment- bond moment and group moment , physical properties(mp, bp, solubility) related to molecular structures.

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(c) Mechanism of Organic Reactions:

Energy of bond cleavage and bond formation , homolytic and heterolytic bond cleavages. Structure, stability, formation and fates of electrophilies, nucleophiles and radicals. Reaction intermediates – carbocations(onium and enium ions), carbanions , carbenes (electrophilic and nucleophilic) , arynes and nitrenes-examples.
Study of a) Electrophilic and free radical addition at C=C , b) Nucleophilic addition at the C=O group of aldehydes and ketones ; c) Nucleophilic substitution reactions - S_N^1 , S_N^2 , S_N^i ; d) Electrophilic substitution in the aromatic system ; Elimination reactions - α and β –eliminations , *syn* – and *anti*-elimination ; E_1 and E_2- mechanism .

Unit-II: **Stereochemistry of Organic Compounds**

Stereoisomerism:

Different types of stereoisomerism ; conformation and configuration . Optical isomerism-optical activity , specific rotation and specific rotation of mixtures , asymmetry and dissymmetry , chirality, elements of symmetry, enantiomers and diastereomers, threo, erythro and meso compounds , representation of molecules in Fischer , flying-wedge , Sawhorse and Newman formulae and their intetranslations . Resolution of racemic mixture, racemisation , asymmetric synthesis-Cram's rule ande Prelog's rule . Relative and absolute configurations, sequence rules, D/L and R/S systems of nomenclature . Geometrical isomerism-determination of configuration of geometrical isomers ; E/Z and *syn* /*anti* nomenclature, geometrical isomerism in oximes and alicyclic compounds .

Conformation: Conformational nomenclature ; eclipsed , staggered , gauche and anti ; dihedral angle , energy barrier of rotation , relative stability of conformers on the basis of steric effects , conformational analysis of ethane , n-butane , cyclohexane and monosubstituted cyclohexanes; stability of cycloalkanes-strains in rings, angle strain and torsional strain , Baeyer strain theory and its limitations.

Unit III : **Aliphatic Compounds , Organic synthesis *via* enolates and Organometallic compounds .**

Aliphatics ; Corey-House synthesis of alkanes ; Synthesis of alkenes, alkynes and alkadienes. Inter conversion of constitutional isomers of alkenes and alkynes ; interconversion of E & Z isomers of alkenes ; synthesis (preparation)of alcohols and ethers, aldehydes and ketones , carboxylic acids and their derivatives, alkyl nitrates , nitro alkanes , nitriles , isonitriles , amines and diazoacetic ester .

Important reactions with mechanism- Markownikoff's addition to alkenes , peroxide effects , ozonolysis, electrophilic and free radical addition to conjucated dienes ; 1,2 vs 1,4- additions ; Birch reduction of alkadienes and alkynes ; catalytic hydrogenation of alkenes and alkynes ; use of Lindler catalyst ; Oppenauer oxidation , Rosenmund reduction , Stephen's reaction , Sommelet reaction., Baeyer-Villiger oxidation , Wolff-Kishner reduction ; Condensation reactions- Aldol, Claisen and Darzen-glycidic ester ; Cannizzaro and Tischenko reactions , Tautomerism .

Organic synthesis via enolates : Active methylene compounds , synthesis and synthetic applications of diethyl malonate and ethyl acetoacetate.

Organometallic Compounds: Preparation and synthetic applications of Grignard reagents , Organolithium Compounds and Organocopper Compounds.

B.Sc Chemistry (Honours) Part-I Syallabus
Paper-IB (Inorganic Chemistry: Theoretical) : 50 Marks
Total Units: Three

Question Pattern

c) One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.

d) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

Unit-1: Atomic Structure

Black body radiation, Planck's Quantum Equation, Atomic spectra of H atom, Bohr's atomic model, Bohr's theory(Including simple mathematical treatment of hydrogen atom), Sommerfeld model(simple), Quantum numbers and their significances, s,p,d and f orbitals, Pauli's exclusion principle. Hund's rule. Aufbau principle and its limitation, Electronic configuration of the elements, effective nuclear charge, Qualitative ideas on photoelectric effect and Compton effect, wave-particle duality, de Broglie relationship, Heisenberg's uncertainity principle, Schrodinger wave equation for stationary states(derivation excluded), significance of ψ & ψ^2 , probability distribution curves, shapes of s,p and d orbitals(qualitative treatment only).

Unit-II: Chemical Bonding

Ionic Bonding:

Lattice energy, Born-Lande equation and its application, Born-Haber cycle and its application, Solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, ionic potential, Fazan's rule.

Covalent Bonding:

VB theory(simple treatment) and it's limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Bent's rule, VSEPR theory.

MO theory (nonmathematical treatment). Bonding, antibonding and nonbonding molecular orbitals, molecular orbital configurations of homonuclear and

heteronuclear (CO, NO, HF) diatomic molecules, elementary ideas of Linnet-quartet theory molecular orbital treatment (qualitative picture) of polyatomic systems such as BeH_2 , CH_4, BCl_3, comparison of VB and MO theory, bondig in electron deficient compounds with reference to alkyls of Be , Al and diborane, percentage of ionic character from dipole moment and electronegativity differences.

Metallic Bond- free electron, valence bond and band theories

Weak interactions- hydrogen bonding, van der Waal's forces.

Unit-III : **Metals :**

Metals :

General methods of isolation of metals from their natural source of occurrence (technical details omitted) . Availability in India and Chemistry of isolation of the following metals :
Li , Ag , Au , Ti , Cr , Mn , Ni , Pt , Th and U .

Prepatration , properties and stereochemistry of the following compounds :

Potassium chromate, Potassium dichromate , Potassium permanganate , Potassium ferrocyanide , Potassium ferricyanide , Nickel tetracarbonyl, Sodium cobaltinitrite.

B.Sc Chemistry (Honours) Part-I Syallabus
Paper-IIA (Physical Chemistry: Theoretical): 50 Marks
Total Units: Three

Question Pattern

e) One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.

f) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

Unit-I: The Gaseous and crystalline states of matter

The Gaseous state:

Gas laws; postulates of kinetic theory of gases; derivation of the kinetic theory of gas equation- $PV= (1/3) mnc^2$; mean free path ; collision diameter; collision number; collision frequency; heat capacity of gases; viscosity of gases- effect of temperature.
Real gases: Deviation from ideal behaviour – Regnault , Andrews and Amagat's experiments on gases; causes of deviation- van der Waals equation; critical phenomenon- critical constants, inter-relationships between critical constants and van der Waal's constants; law of corresponding states.
Maxwell distribution of molecular velocities (no derivation) – most probable, average and root mean square velocities- their inter-relationship; Boltzmann equation (without derivation).

The Crystalline state:

Three laws of crystallography: Weiss and Miller indices; unit cell, seven crystal systems; 14 Bravais lattices; crystal packing; radius ratio- co-ordination number, X-ray diffraction (SRD) of crystals- derivation of Bragg's equation ; determination of crystal parameters of cubic systems- crystal structure of KCl, NaCl, CsCl, diamond, graphite, boron nitride and ice, defects in crystals- point defects- Schottky and Frenkel defects, color center, semi-conductors.

Unit-II: Thrmodynamics and Kinetics

Thrmodynamics:

Thermodynamic apparatus- system, surroundings, various types of systems and processes isothermal, isobaric, isochoric processes, reversible, irreversible, adiabatic, cyclic etc.

processes thermodynamic parameters, perfect and imperfect differentials; thermodynamic laws- zeroth law.
First law of Thermodynamics: statement, mathematical form, concept of enthalpy and heat capacity of gases, Cp and Cv, their interrelationships, Joule's experiment, Joule-Thompson effect, liquefaction of gases.
Thermochemistry- exothermic and endothermic reactions, enthalpy (heat) of formation, reaction, combustion, solution, neutralization, atomization, etc.; laws of thermochemistry, bond dissociation energy, Born-Haber cycle.
Chemical Kinetics:
Order and molecularity of reaction, rate of reaction, rate laws and rate equations, differential and integral forms of rate equation- zero order, first order and second order reactions, half life and average life, experimental methods for the determination of order of reactions, effect of temperature on the rate of reaction, Arrhenius equation, concept of activation energy, collision theory and transition state theory of reaction rates.

Unit-III: **The Liquid State and Solution Properties.**

The Liquid State:
Physical properties of liquids including their experimental methods of determination, internal pressure, vapour pressure, surface tension, viscosity, effect of temperature on these properties, structure of liquid and liquid crystals(elementary idea).

Solution Properties:
General features of solutions: Types of solutions, ideal and non-ideal solutions, modes of expression of composition of solutions-molarity, molality, normality, mole fraction and percentage, solutions of gases in liquids, Henry's law.
Properties of dilute solutions: Extensive and intensive properties, additive, constitutive, and colligative properties, Raoult's law of relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmosis- laws of osmosis, experimental methods of determination of properties of dilute solution- determination of molecular weight of substances based on these properties-their inter-relationships and their thermodynamic derivation, analogy between ideal gas and dilute solution , abnormal solution properties, van't Hoff factor.

B.Sc. Chemistry (Honours) Part-I Course
Paper II B (Practical): 50 Marks
Duration of Examination: 6 Hours (1 day)
Physical Chemistry and Organic Chemistry Experiments

Distribution of marks: Physical Chemistry Experiment: 25 Marks
Organic Chemistry Experiments: 15 Marks
Laboratory Note Books : 5 Marks
Viva-voce : 5 Marks

Unit-I: **Physical Chemistry Experiments**

Duration of Examination: 3 ½ hours.

The following experiments are to be performed by the students.

Exp. No.	Experiment Titles
1.	Determination of surface tension of a given liquid / solution with a stalagmometer by drop weight method.
2.	Determination of viscosity coefficient of a given liquid / solution by Ostwald's viscometer.
3.	Determination of distribution coefficient of iodine between water and an organic solvent.
4.	Determination of distribution coefficient of an organic acid between water and an organic solvent.
5.	Determination of pH of a buffer solution by colour matching of indicator.
6.	Determination of concentration of each of HCl and CH_3COOH in a mixture conductometrically using standard NaOH solution.

All the experiments are equivalent. At least four experiments are to be set in the practical examination. Each candidate at the examination shall be assigned with one of these experiments through single draw lottery.

Unit-II: **Organic Chemistry Experiments**

Duration of Examination: 2 ½ hours.

The following organic compounds are to be prepared using typical organic reactions. The isolation, purification and mp determination of the product will be required.

Exp.No.	Experiment Titles
1.	Preparation of benzil by oxidation of benzoin.
2.	Preparation of p-nitroacetanilide by nitration of acetanilide .
3.	Preparation of phthalimide by condensation reaction of phthalic anhydride with urea.
4.	Preparation of p-bromo acetanilide by bromination reaction.
5.	Preparation of dibenzylidene acetone by condensation reaction.

Only one experiment for preparation is to be set in the practical examination.

B. SC (PASS) PART-II SYLLABUS
Chemistry (Theoretical): 100 Marks
Total Units: Six
(Separate answer scripts are to be used by the examinees for each Group)
Group A: Organic Chemistry marks (two units) : 33

Question Pattern

g) One Compulsory question (Q.No.1) is to be set with six(short/ multiple choice/ both) questions of 1 mark each from two units, of which three are to be answered.

h) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered. Each question of 15 marks may be divided into three or more parts having a maximum of 6 marks for a part.

UNIT – I:

(i) **Active methylene Compounds:** Active methylene group, synthesis and applications of ethyl acetoacetate, and diethyl malonate in organic synthesis, tautomerism.

(ii) **Organic Compounds:** Introduction, Grignard reagents – their structures, formation and reactivity application of Grignard reagents in organic synthesis and its limitations.

(iii) **Organic Compounds Containing nitrogen (aliphatic):** Methods of synthesis and reactions of nitroalkanes, alkyl nitrites, alkyl cyanides, isocyanides. Introduction to amino compounds, general methods of synthesis, basicity and effect of substituents, chemical reactivity, distinction and preparation of primary, secondary and tertiary amines, important aliphatic amines.

(iv) **Phenols:** Synthesis, physical properties, acidic character, chemical reactions, Kolbe reaction, Reimer – Tiemann reaction, Fries rearrangement, Claisen rearrangement, Houben-Hoesch reaction, Phenol – Formaldehyde Resin, cresols, nitro and amino phenols, dihydric and trihydric phenols.

UNIT II:

(i) **Aromatic alcohols , Aldehydes, Ketones:** Introduction, general methods of synthesis, physical properties, chemical reactivity of aromatic alcohols , aldehyde and ketones, Perkin reaction, phenolic aldehydes, benzoin condensation.

(ii) **Stereochemistry of Organic Compounds:**Relative and absolute configaration, D/L and R/S nomenclature of acyclic system, *erythro* and *threo* configarations, inversion and retention of configaration, Fischer, Newman and Sawhorse formulae.

(ii) **Cyclo alkanes:** Bayer's Strain theory and theory of strainless rings.Conformation of cyclohexane (boat, twist boat, chair forms) and its mono substituted derivatives, axial and equatorial bonds.

Group B: Inorganic Chemistry(two units) marks : 34

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with eight (short/ multiple choice/ both) questions of 1 mark each from two units, of which four are to be answered.
b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered. Each question of 15 marks may be divided into three or more parts having a maximum of 6 marks for a part.

UNIT – I:

i) **Periodicities of elements:** Periodic classification of elements on the basis of electronic configuration. Periodic properties – atomic radii, ionic radii, ionization potential, electronaffinity, electronegativity principle, Pauling's scale of electronegativity, group electronegativity.

ii) **Acids & Bases:** Modern concept of acids and bases – Bronsted-Lowery, Lewis, SHAB principle, strength of acids and bases (qualitative idea). Theory of solvent systems.

iii) **Redox reactions:** Ion electron method of balancing equations, equivalent weights of oxidant and reductant. Chemical problems involving oxidometry and reductometry (in relation to the corresponding syllabus in practical paper), redox potentials and its application in precipitation reactions and complex formation, choice of indicators in redox titrations.

UNIT – II:

i) **S – block elements:** Trends in physical and chemical properties of the elements and their important classes of compounds. Solvation including liquid ammonia) and complexation tendencies. Chemistry of lithium and beryllium – anomalous and diagonal relationship.

ii) **Comparative study:**
P-block elements (III – VII) and zero group: Group trends in electronic configuration, structure of elements, atomic and ionic radii, ionization potential, electron affinity, electronegativity, oxidation states, inert pair effect, catenation and important classes of compounds such as hydrides, oxides, oxy acids, halides and complexes (including stereochemistry), compounds of noble gases.

ii) Preparation, properties, bonding and stereochemistry of the following as mentioned:

a. Diborane

b. Carbides (preparation, properties and technical applications)
c. Hydrazine, hydroxylamine, hydrazoic acid, oxides and oxy acids of nitrogen.
d. Oxygen fluorides, oxides, oxy acids and halides of sulphur, selenium and tellurium, per acids of sulphur.
e. Oxides and oxy acids of halogens (structures only), interhalogen compounds, basic properties of halogens.

Group C: Physical Chemistry (Two Units) marks : 33

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with six (short/ multiple choice/ both) questions of 1 mark each from two units, of which three are to be answered.
b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered. Each question of 15 marks may be divided into three or more parts having a maximum of 6 marks for a part.

UNIT – I:

i) **Thermochemistry:** exothermic and endothermic reactions; enthalpy (heat of of formation, reaction, combustion, solution, neutralization, atomization, etc., laws of thermochemistry, bond dissociation energy, Born – Haber cycle.
ii) **Second law of thermodynamics:**
need for a second law, spontaneous process, reversible process, statements of second law, heat engine, Carnot cycle, Carnot engine and its efficiency, concept of entropy, entropy change in simple transformations, physical significance of entropy.
iii) Gibb's free energy, Helmholtz free energy, Gibbs Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of a process.
iv) Equilibrium between different phases: Clausius equation, Clausius-Clapeyron, Trouton's rule, Craft's rule, Hilde-Brand's rule.
v) Van't Hoff equilibrium box: Thermodynamic derivation of equilibrium constant, van't Hoff reaction isotherm, van't Hoff equation, reaction isochore.

UNIT – II:

i) **Electrical conduction through solution:** Arrhenius theory of electrolytic dissociation, mode of transport of electricity through solution, transport number of ions, experimental method of determination of transport number – Hittorf's method, abnormal transport number, specific equivalent and ionic conductances, ionic mobility, absolute velocity of ions, strong and weak electrolytes, Kohlrausch's law and its applications, measurement of conductance of solutions, applications of conductance measurement, conductometric titrations. Solubility of sparingly soluble salts.
ii) **Theory of strong electrolytes:** Ion atmosphere, relaxation effect, Debye-Huckel Onsagar equation, Debye-Huckel limiting law, ionic strength,

dependence of activity coefficient on ionic strength, determination of activity and activity coefficient from EMF measurements.

iii) **Ionic equilibrium:** Ostwald dilution law, ionization of water, pH, buffer solution, buffer capacity, mechanism of buffer action, Henderson equation, hydrolysis of salts, common ion effect,solubility product, application of solubility product, principle in analytical chemistry, ionic strength.

iv) **Electrochemical cells:** Galvanic cells, vis-à-vis electrolytic cells, reversible and irreversible cells, standard cells – Western & cadmium, free energy change in galvanic cells, electrode potential, type of electrodes, standard oxidation/reduction potential, sign convention, potentiometric titration, setting up of simple cells, writing of cell reaction, elementary ideas of polarization and over voltage, successive anodic and cathodic processes.

B.SC PART-II (PASS) PRACTICAL SYLLABUS
Paper-III, Marks: 100

Group-A:	Organic Chemistry Practical -	25 Marks,	Time- 6 hours
Group-B:	Inorganic Chemistry Practical -	25 Marks,	Time- 6 hours
Group-C:	Physical Chemistry Practical -	30 Marks,	Time- 4 hours
Group-D:	Laboratory Note Books and Viva-voce -	20 Marks	

DISTRIBUTION MARKS

Group-A: Organic Chemistry Practical

1. Quantitative analysis: 15 Marks
2. Qualitative analysis: 10 Marks

Organic Quantitative analysis:

Experiments to be performed

1. Estimation of aniline using brominating mixture
2. Estimation of glucose by Benedict reagent

Organic Qualitative analysis:

1. Identification of a pure solid organic compound through detection of special elements (nitrogen, sulphur, halogens) functional groups (phenolic-OH, -COOH, -CHO, >CO, $-NH_2$, $-NO_2$, $-CONH_2$, >C=C<).

Group-B: Inorganic Chemistry Practical

1. Inorganic qualitative analysis: 15 Marks
2. Inorganic preparation: 10 Marks

1. Inorganic qualitative analysis:

The list of qualitative analysis of inorganic salt mixtures containing not more than three radicals from the following radicals:

Silver, lead, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, chromium, manganese, cobalt, zinc, nickel, calcium, barium, strontium, magnesium, potassium, ammonium; chloride, bromide, iodide, sulphate, sulphide, sulphite, phosphate, borate, nitrate, nitrite, arsenate, oxides and hydroxides.

2. Inorganic preparation:

The list of compounds to prepared:

1. Lead iodide
2. Tetraminecopper(II) sulphate
3. Common alum
4. Bis-(dimethylglyoxamato)nickelate(II)

Group-C: Physical Chemistry practical

List of the experiments are to be performed by the students (at least three experiments are to be set in the examination and students are to be performed only one experiment):

1. Determination of the surface tension of a supplied liquid solvent/ solution by drop volume method.
2. Determination of the coefficient of viscosity of a given liquid/solvent using Oswald viscometer.
3. Determination of the partition coefficient of iodine between water and an organic solvent.
4. Determination of pH of a buffer solution by colour matching method.
5. Determination of concentration of HCl/NaOH by conductance method.

Group-D: Laboratory Note Books and Viva-voce - 20 Marks

1. Laboratory note books (Organic, Inorganic and Physical Chemistry Experiments):10 Marks
2. Viva-voce on the experiments of organic, inorganic and physical chemistry as well practical related general chemistry: 10 Marks

B. SC CHEMISTRY (PASS) PART-III SYLLABUS

Chemistry (Theoretical): 100 Marks

Total Units: Six

(Separate answer scripts are to be used by the examinees for each Group)

Group A: Organic Chemistry marks(two units) : 33

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with six (short/ multiple choice/ both) questions of 1 mark each from two units, of which three are to be answered.
b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered. Each question of 15 marks may be divided into three or more parts having a maximum of 6 marks for a part.

UNIT - I

(i) **Carbohydrates:** Introduction, occurrence, classification, nomenclature, interrelationship amongst monossaccharides, constitution of glucose and fructose, ribose and arabinose. Reactions of glucose and fructose, osazone formation, mutarotation and its mechanism, cyclic structures, pyranose and furanose forms. Determination of ring size. Haworth projection formula, configuration and confirmational analysis of monosaccharides, epimerisation, ascending and descending of sugar, interconversion of aldoses and ketoses.

(ii) **Proteins:** Methods of synthesis, physical and chemical properties and structures of common alpha amino acids, isoelectric points, peptide synthesis. (including Merrifield)

(iii) **Nucleic acids:** Compounds of nucleic acids, pyrimidine and purine bases, nucleosides, nucleotides, structure of nucleic acids (Watson-Crick model).

UNIT – II: Polynuclear aromatic hydrocarbons and heterocyclic compounds

Polynuclear aromatic hydrocarbons (naphthalene, anthracene, phenanthrene); Aromatic heterocycles with one heteroatom: Introduction, five and six membered heterocycles, aromatic characteristic of heterocyclic compounds, structure, synthesis and reactions of furan, thiophene, pyrrole and pyridine, basicity of pyridine and piperidine.

Quinones: Benzoquinones and naphthoquinones – preparations, properties, structures and reactions

Group B: Inorganic Chemistry (two units) marks : 33

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with six (short/ multiple choice/ both) questions of 1 mark each from two units, of which three are to be answered.

b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered. Each question of 15 marks may be divided into three or more parts having a maximum of 6 marks for a part.

UNIT – I: Chemical Bonding

Molecular orbital theory (non mathematical treatment), bonding, antibonding and nonbonding orbitals, molecular orbital configurations of simple diatomic molecules (H_2, He_2, O_2, N_2, F_2, CO, NO, HF). Elementary ideas of Linnet quartet theory, molecular orbital treatment (qualitative picture) on poly atomic systems such as BeH_2, comparison of valence bond and molecular orbital theories. Bonding in electron deficient compounds with reference to alkyls of beryllium and aluminum.

UNIT – II: Metals

General methods for isolation of metals from their natural sources of occurrence (technical details are omitted). Availability in India and chemistry of isolation of the following metals: Li, Ag, Au, Ti, Cr, Ni and U.

Preparation, properties and stereochemistry of the following compounds: potassium chromate, potassium dichromate, potassium permanganate, potassium ferrocyanide,

Group C: Physical Chemistry (two units)marks : 34

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with eight (short/ multiple choice/ both) questions of 1 mark each from two units, of which four are to be answered.
b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered. Each question of 15 marks may be divided into three or more parts having a maximum of 6 marks for a part.

UNIT – I:

i) **Solid state:** Nature of solid state, laws of crystallography, Weiss and Miller indices, unit cell, crystal systems, Bravis lattice, symmetry elements, types of crystals, crystal forces.

X-ray diffraction of crystals, Bragg's law, methods of determination of crystal parameters, packing efficiency, radius ratio, crystal structure of NaCl, CsCl, diamond, graphite.

Heat capacity of solids – atomic heat capacity, Dulong – Petit law. Kopp – Neumann law, explanation of specific heat of solids – classical, Einstein and Debye models (elementary ideas only and only the final equations), Debye T^3 law (only the equation without derivation).

ii) **Physical properties and molecular constitution:** Additive and constitutive properties – molar volume at boiling point, parachor, rheochor, refractive index, molar refraction, optical activity, specific and molar rotation, dielectric

constant, induced and orientation polarization, polar and non-polar molecules, dipole moment and its experimental methods of determination, Clausius-Mosotti equation, ionic character of bonds. Debye equation, elementary ideas of diamagnetism and paramagnetism.

iii) **Thermodynamic derivations:** Thermodynamic derivation of properties of dilute solution: Raoult's law of relative lowering of vapour pressure, osmosis and osmotic pressure, elevation of boiling point, depression of freezing point – their interrelationship.

UNIT – II:

i) **Theory of indicators:** Detailed concept of acid base indicators; types criteria and selection of indicators.

ii) **Concentration Cell:** Cell with and without transference, liquid junction potential, determination of pH using hydrogen electrode, quinhydrone and glass electrodes, polarization and overvoltage related theories. Tafel equation, successive anodic and cathodic processes. Lead accumulator and alkali accumulator.

iii) **Systems of variable composition:** Partial molal quantities, chemical potential of component in an ideal mixture. Gibb's Duhem relations, determination of partial molal quantities, fugacity, activity and activity coefficient.

B.SC CHEMISTRY (HONOURS) PART-II SYLLABUS

Paper-IIIA (Organic Chemistry): 50 Marks

Total Units: Three

Question Pattern

a) One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.
b) Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT – I:

i) **Aromatic hydrocarbon and aromaticity:** Sources, nomenclature and isomerisation of aromatic compounds, structure of benzene, stability of benzene ring, molecular orbital picture of benzene, aromaticity, Huckel's (4n+2) rule and its simple applications. Electrophilic substitution reactions in aromatic compounds. General mechanism of aromatic electrophilic substitution, effect of substituent groups, directive influence, orientation, isotope effect, nitration, sulphonation, halogenation, Friedel-Craft's alkylation and acylation, energy profile diagram, nuclear and side chain halogenation.

ii) **Aromatic halogen compounds:** Introduction, method of synthesis, physical properties, chemical reactivity, nucleophilic aromatic substitution and its mechanism.

iii) **Aromatic compounds containing nitrogen:** Introduction, methods of synthesis and physical properties, mechanism of nitration, reduction products of nitro compounds. Introduction, methods of synthesis of aromatic amines, basicity and effect of substituents, chemical reactivity. Diazotization and reactions of diazonium salts.

iv) **Phenols:** Synthesis, physical properties, acidic character, chemical reactions, Kolbe reaction, Reimer – Tiemann reaction, Fries rearrangement, Claisen rearrangement. Houben – Hoesch reaction, phenol – formaldehyde resin, cresols, nitro and amino phenols, dihydric and trihydric phenols.

v) **Aromatic alcohols, aldehydes, ketones:** Introduction, methods of synthesis, physical properties, chemical reactivity of aromatic alcohols, aldehydes and ketones, Perkin reaction, phenolic aldehydes, Benzoin condensation.

UNIT - II

i) **Polynuclear Aromatic Hydrocarbons:** Introduction, structure, physical properties, chemical reactivity and synthesis of naphthalene, anthracene and phenanthrene. Some important derivatives of naphthalene, such as, naphthol, naphthylamines and naphtholic acids., carcinogenocity.

ii) **Quinones:** Quinones of benzene, naphthalene and anthracene – preparation, properties, structures and reactions.

iii) **Heterocyclic compounds:** Introduction, five and six membered heterocycles, aromatic character, nomenclature, structure, synthesis and chemical reactivity of furan, pyrrole, thiophene, pyridine and piperidine, basicity of pyrrole, pyridine and piperidine.

Introduction to condensed five and six membered heterocycles, synthesis and reactivity of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler Napieralsky synthesis.

UNIT – III : BIO-MOLECULES

i) **Carbohydrates:** Introduction, occurrence, classification, nomenclature, inter-relationship amongst monosaccharides, constitution of glucose and fructopse, ribose and arabinose, reactions of glucose and fructose, osazone formation, mutarotation and its mechanism, cyclic structures, pyranose and furanose forms, determination of ring size. Haworth projection formula, configurations and conformational analysis of monosaccharides, epimerisation, ascending and descending of sugars, interconversion of aldoses and ketoses.

Introduction to disaccharides – maltose, lactose and sucrose . Introduction to polysaccharides – starch and cellulose.

ii) **Proteins:** Introduction, alpha-amino acids – synthesis (including enantioselective) physical and chemical properties, iso-electric points, peptide synthesis and determination of C and N terminal amino acid residues, proteins classification, chemical test. Structure determination and estimation.

iii) **Nucleic acids:** Components of nucleic acids (elementary ideas).

B.SC PART-III (PASS) PRACTICAL SYLLABUS
Paper-IV, Group B (Organic & Inorganic)
Marks: 30
Time : 6 hours

Distribution of Marks:

1. Organic Compound Preparation:	10 Marks
2. Inorganic Quantitative Analysis:	15 Marks
3. Laboratory Note Books:	02 Marks
4.Viva-voce:	03 Marks

1. **Organic Compound Preparation:**

List of compounds to be prepared in pure state:

i) Phthalimide
ii) Benzil
iii) Iodoform
iv) Dibenzylidene acetone

(Any of the above compound is to be set in the examination)

2. **Inorganic Quantitative Analysis:**

List of experiments:

i) Estimation of Fe^{2+}/Fe^{3+} in Mohr's salt /supplied sample
ii) Estimation of Cu^{2+} in blue vitriol/supplied sample
iii) Estimation of Ca^{2+} in supplied sample

B.SC CHEMISTRY (HONOURS) PART-II SYALLABUS
Paper-IIIB (Inorganic Chemistry: Theoretical) : 50 Marks
Total Units: Three

Question Pattern

a. One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.
b. Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT – I:

i) **Periodic Properties:** Periodic classification of elements on the basis of electronic configuration. Atomic radii, ionic radii, ionization energy, electronaffinity and electronegativity. Pauling's scale of electronegativity, group electronegativity, Sanderson electronegativity ratio.

ii) **Acids and Bases:** Modern concept of acids and bases including SHAB principle, strength of acids and bases (qualitative idea)

iii) **Redox Reactions:** Ion electron method of balancing equations, redox potential and its applications, influence of pH, precipitation and complex formation on redox potential; choice of indicators in redox titrations.

UNIT – II: Chemistry of p-Block elements and their compounds

a. Occurance, extraction/preparation/isolation, purification and storage as applicable of some selected elements (omitting technical details)
b. Preparation, properties, reactions and technical uses (omitting technical details)
c. Structure(*)and bonding(*) of some simple compounds in respect of the following periodic groups.

Group 13: B, diborane(*), borazole(*), boron nitride;
Group 14: Carbides, Si, silicones, silicates, aluminosilicates, glass; Ge; Sn, $SnCl_2$; Pb, PbO_2, Pb_3O_4, tetra alkyl lead, lead tetra acetate;
Group 15: Hydrazine, hydroxyl amine, hydrazoic acid, sodium azide; phosphonitrilic compounds (*), phosphagene polymers, polyphosphoric acids; arsenious oxide; Sb, SbF_5; Bi, $NaBiO_3$.
Group 16: Peroxy monosulphuric acid and peroxy disulphuric acids and their salts, sodium thiosulphate, sodium dithionite, thionic acid, sulphur nitrogen compounds(*); Se, SeO_2, H_2SeO_4 and H_2TeO_4 and their salts;
Group 17: $HClO_4$, $KBrO_3$, HIO_4, $KHIO_3$, KIO_3, KIO_4, basic properties of halogens, interhalogen compounds(*), polyhalides(*), pseudohalides(*),fluorocarbons, freons;
Group 18: Noble gases from air,(isolation, properties and uses), xenon fluorides(*);

UNIT – III:

i) **Nuclear Chemistry:** Possible forces operated between n – n, p – p, n – p and the magnitude of nuclear forces, qualitative idea of the stabilities on the nucleus (n/p ratio), binding energy, mass defects, Einstein's mass-energy relation, separation of isotopes, natural and artificial radioactivity, measurement of radioactivity, radioactive disintegration, group displacement law, disintegration series, half life, radioactive equilibrium, application of radioactivity, artificial transmutation of nuclei, nuclear reactions, spallation, nuclear fission and fusion.

ii) **Coordination Compounds:** Double salts and complex salts, perfect and imperfect complexes, detection of complex formation in solution, Werner's coordination theory and its experimental verification, effective atomic number rule, types of ligands, chelates, inner metallic complexes and their application in analytical chemistry, nomenclature of coordination compounds, stereochemistry of different coordination numbers, isomerisation in coordination complexes, valence bond theory of coordination compounds.

B.SC CHEMISTRY (HONOURS) PART-II SYALLABUS
Paper-IVA (Physical Chemistry: Theoretical): 50 Marks
Total Units: Three

Question Pattern

a. One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.
b.Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT – I:

i) **Physical properties:** Additive and constitutive properties- molar volume at boiling point, parachor, rheochor, molar refraction, refrachor, optical activity , specific and molar rotation-optical rotatory dispersion (ORD) and circular dichroism (CD), dielectric constant, molar polarization, induced and orientation polarizations, polar and non-polar molecule dipole moment-Clausius Mosotti equation, Debye equation, experimental methods for the determination of dipole moment, magnetic properties; paramagnetism, diamagnetism and ferromagnetism. Ascertaining structure of molecules using above properties.

ii) **Second law of thermodynamics:** Need for the law, spontaneous process, statements of second law, mathematical derivation of second law, carnot engine, carnot cycle, efficiency of heat engine, concept of entropy, entropy change in simple systems, physical significance of entropy – entropy and probability. Gibb's free energy and Helmholtz free energy. Gibb's Helmholtz equation, thermodynamic criteria for spontaneity and equilibrium state of system. Nernst Heat Theorem – third law of thermodynamics (statement only).

iii) **Chemical equilibrium:** Reversible and irreversible reactions, law of mass action, equilibrium constant, expression for equilibrium constants in various equations, themodynamic derivation of law of mass action using free energy change and Van't Hoff equilibrium box, Le Chatelier principle. Interrelationship between K_p, K_c and K_x , Reaction isotherm, reaction isochore, Van't Hoff equation, equilibrium in phases –Clapeyron equation, Clausius – Clapeyron equation.

UNIT – II: SURFACE PROPERTIES

i) **Adsorption:** Absorption vis-à-vis adsorption; types adsorption; theories of adsorption; Freundlich, Langmuir and Gibb's adsorption isotherms – their derivation; BET equation; determination of surface area of adsorbates; application adsorption phenomenon in nature and industry.

ii) **Catalysis:** Classification; criteria for a good catalyst; catalyst promoters and catalyst poisons; theories of catalysis; application of catalyst in the

manufacture of ammonia; nitric acid and sulphuric acid; acid base catalysis and enzyme catalysis.

iii) **Colloids:** Definition, classification, preparation and purification of colloids, properties of colloids – physical, mechanical (Brownian motion), optical (Tyndal effect), electrical (Zeta potential) properties, stability and protective action of colloids – Gold number; Hurdy – Schulze rule, coagulation, peptisation, salting out, mechanism of functioning of soap and detergents, micelle formation; critical micelles concentration (CMC), emulsions, application of colloids – determination of Avagadro's number from Perrin distribution equation and Einstein diffusion equation.

iv) **Photochemistry:** Interaction of radiation with matter, difference between dark (thermal) and photochemical reactions; elementary ideas of phosphorescence, fluorescence, luminescence; laws of photochemistry – Grothus – Draper law, Stark – Einstein law, Lambert law, Beer law, Lambert – Beer law, quantum yield and quantum efficiency; photochemical equilibrium; photosensitized reactions; photosynthesis and photochemistry of air and air pollution;

UNIT – III: ELECTROCHEMISTRY

i) **Electrical transport:** Conductance of electricity through metals.Arrhenius theory of electrolytic dissociation; mode of transport of electricity through electrolytic solutions; transport number; experimental determination of transport number of ions by Hittorf's method and moving boundary method; abnormal transport number and causes thereto; measurment of conductance of solution; specific and equivalent conductance; ionic mobility; Kohlrausch law and its application; theory of strong electrolytes-Debye Huckel-Onsager equation (no derivation), ionic strength, Debye-Huckel limiting law; activity and activity co-efficient application of conductance measurements – conductometric titrations, solubility of sparingly soluble salts.

ii) **Ionic Equilibrium:** Ostwald dilution law; ionization of water; ionic product of water; pH; buffer solution, buffer action and buffer capacity. Henderson equation, hydrolysis of salt, common ion effect, solubility product, - application of solubility product principle in analytical chemistry. Indicators – types, criteria for good indicators, theory of acid base indicators.

iii) **Electromotive force:** measurement of e.m.f., Weston-cadmium cell, types of reversible electrodes, e.m.f of reversible cells, Nernst equation, single electrode potentials, sign convention of e.m.f. a cell, reference electrode – calomel, quinhydrone electrodes, standard electrode potential, electrochemical series, setting up of simple cells, cell reaction, application of e.m.f. mearurements – determination of ionic activity, equilibrium constant, potentiometric titration, elementary ideas of polarization and over voltage- Taufel equation (no derivation), successive anodic and cathodic processes, Lead and alkali accumulators.

iv) **Concentration cells:** Cells with and without transference, liquid junction potential, corrosion- types of corrosion, theory of corrosion and methods for combating corrosion.

B. SC PART-II (HONOURS) PRACTICAL SYLLABUS
Paper-IV (Group-B) Marks: 50 Marks
(Organic & Inorganic)
Time : 10 hours

Distribution Marks:

1. Organic Quantitative analysis:	20 Marks, Time – 4 hours
2. Inorganic Quantitative analysis:	20 Marks, Time – 6 hours
3. Laboratory Note Books:	05 Marks
4. Viva-voce:	05 Marks

1. **Organic Quantitative Analysis**:

The list of experiments to be performed:-

2) Estimation of aniline using brominating mixture
3) Estimation of glucose using Benedict reagent
4) Estimation of glycine using Sorensen formol titration

Any one of the experiments to set in the examination.

2. **Inorganic Qualitative Analysis:**

(Qualitative analysis of mixtures of inorganic samples containing not more than four radicals from the following list):

Silver, lead, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, chromium, manganese, cobalt, zinc, nickel, calcium, barium, strontium, magnesium, potassium, ammonium; fluoride, chloride, bromide, iodide, sulphate, sulphide, sulphite, phosphate, arsenite, arsenate, borate, nitrate, nitrite, ferrocyanide, ferricyanide, chromate, bromate, iodate, thiocyanate, silicate.
(Probable composition of the analyzed mixture be stressed upon)

B.SC CHEMISTRY (HONOURS) PART-III SYALLABUS
Paper-VA (Organic Chemistry: Theoretical): 50 Marks
Total Units: Three

Question Pattern

a. One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.

b.Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT – IA:

i) **Bifunctional compounds:** General methods of preparartion, properties, reactions with mechanism of the bifunctional compounds – diols, hydroxy ketones, hydroxy aldehydes, dicarbonyl compounds, keto acids, unsaturated ketones, acids and lactones.

ii) **Stereochemistry:** Atropisomerism, biphenyl (excluding R/S configuration), substituted allenes, elementary ideas of stereospecific and stereoselective reactions.

iii) **Carbenes:** Definition, classification on the basis of spin states, stereospecificity in its reactions.

UNIT – IB: SPECTROSCOPY

i) **Ultraviolet and Visible spectroscopy:** Introduction, theory, instrumentation and sample handling solvent effects, characteristic absorption of organic compounds, application of rules for calculation of λ_{max} polyenes and dienones.

ii) **Infrared Spectroscopy:** Introduction, theory, instrumentation, sample handling, characteristic group frequencies of organic molecules, factors affecting group frequencies.

iii) **Proton NMR spectroscopy:** Introduction, theory, sample handling, chemical shift and factors influencing it, spin-spin coupling, charactersistic chemical values of different kind of protons, application of UV, IR and NMR in structure elucidation of organic molecules.

UNIT – IIA:

Pericyclic & Photochemical Reactions: Definition and classification, electrocyclic reactions: FMO approach, example of electrocyclic reactions (thermal and photochemical) involving 4π and 6π electrons and corresponding cycloreversion reaction, cycloaddition reactions: FMO approach, DA reaction, photochemical [2+2] reactions. Sigmatropic shifts and their orders, [1,3] and [1,5] hydrogen shifts and [3,3] shifts with reference to Claisen and Cope rearrangement. Photochemical reactions of carbonyl compounds, alkenes and arenas with reference to Norish – I & II cleavage reaction, PaternoBuchii and di pi methane rearrangement.

UNIT – IIB:

i) **Dyes:** Relation between colour and constitution, chromophore, auxochrome, valence bond theory of colour (ultraviolet visible absorption spectrum), classification of dyes, preparation and uses of phenolphthalein, methyl orange, congo red, malachite green, alizarin and indigo.

ii) **Drugs and pesticides:** Introduction, classification of drugs, preparation and uses of aspirin, phenacetin, sulphanilamide, sulphaguanidine, quinine.

Pesticides: Introduction, Classification, general survey of natural and synthetic pesticides, preparation and uses of DDT, endrin, parathion and baygon.

UNIT – IIIA: NATURAL PRODUCTS

i) **Terpenoids:** Introduction, classification, isoprene rule, isolation, structure elucidation and synthesis of citral, terpeneol, geraniol and limolene.

ii) **Alkaloids:** Introduction, classification, isolation, structure elucidation and synthesis of nicotine, piperine, cocaine and coniine.

UNIT – IIIB:

i) **Molecular rearrangements:** Allylic, Claisen, Pinacol-Pinacolone, Demjanov and Favorskii.

ii) **Introduction to organic synthesis:** Formation of C – C bonds, base catalysed and acid catalysed reactions with special reference to aldol, Claisen, Reformatsky, Perkin, Knoevenagel, Dieckmann, Michael, Darzens and Mannich reactions, application of organomagnesium, organolithium and organozinc compounds.

B.SC CHEMISTRY (HONOURS) PART-III SYALLABUS
Paper-VB (Inorganic Chemistry: Theoretical): 50 Marks
Total Units: Three

Question Pattern

a. One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.
b. Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT – IA: STATISTICAL TREATMENT OF DATA ANALYSIS

i). **Evaluation of analytical data:** Accuracy and precision methods for their expression, classification of errors, detection and correction of determination and indetermination errors. The normal law of distribution of indetermination errors.

ii) **Statistical sets of data:** The F and T tests, rejection of data, methods of least squares, propagation of errors in computation, significant figures.

UNIT – IB: LANTHANIDE AND ACTINIDES

i) **Lanthanides:** General study, electronic configuration, oxidation states, magnetic properties and complexation behavior, contraction and seperation.

ii) **Actinides:** Discovery, electronic configuration, oxidation states, magnetic properties, comparison with lanthanides.

UNIT – IIA:

Solids: Band theory, metals, semiconductors, insulators, defects in solids, conduction in ionic solids, introduction to superconductors.

UNIT – IIB:

Coordination Compounds: Stability of complexes, factors influencing stability, stability of unusual oxidation states, determination of stability constants – potentiometric method, determination of composition of complexes by Job's methods, elementary ideas of valence bond theory and crystal field theory to explain bonding in transition metal complexes, explanation of magnetic properties, geometry and colour of coordination complexes on the basis of the above theories. Introduction to ligand field theory (qualitative treatment only)

UNIT – IIIA:

Organometallics Compounds: Definition, classification and nomenclature of organometalllic compounds. Alkyls and aryls of lithium, silicon and mercury (preparation and uses). 18 electron rule and its applications to carbonyls (including carbonyl hydrides and carbonylates), nitrosyls, cyanides and metal carbon sigma- and pi- bonded organometallic compounds of transition metals. Simple examples of metal-metal bonded compounds and metal clusters. Metal – olefin complexes; Zeise's salt (preparation, structure and bonding), ferocene(preparation, structure and reactions). Hapticity (η) of organometallic ligands, examples of mono-, tri- and penta hapto cyclopentadienyl complexes. Coordinative unsaturation: oxidative addition and insertion reactions. Homogeneous catalysis by organometallic compounds (examples excluding mechanism): hydrogenation, hydroformylation and polymerization of alkenes (Zigler-Natta catalysis).

UNIT – IIIB:

Bioinorganic Chemistry: Essential and trace elements in biological systems, metallomorphyrins, chlorophyll and heme proteins and vitamin B_{12}. Fixation of nitrogen, Role of metals and nonmetals in metabolism. Metal and non-metal deficiency. Toxicity, use of coordination compounds in medicine.

B.SC CHEMISTRY (HONOURS) PART-III SYALLABUS
Paper-VIA (Physical Chemistry: Theoretical): 50 Marks
Total Units: Three

Question Pattern

a.One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.
b.Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks.

UNIT I: MOLECULAR SPECTRA

Electromagnetic radiation – Interaction of matter with electromagnetic radiation, quantisation of different forms of energy viz. translational, rotational, vibrational and electronic energy in molecules, Born – Oppenheimer Approximation, types of spectra – absorption and emission spectra, atomic or line spectra and molecular or band spectra.

Rotational Spectra of diatomic molecules, energy levels of a rigid rotor, selection rules, anharmonicity, fundamental modes of vibration, overtones, Morse curves.

Vibrational Spectra: Hook's law, expression for vibrational energy in terms of quantum number, force constant, selection rules, bond energy, bond distance, isotope effect, vibrational frequency of different functional groups.

Raman Spectra: Origin, Stokes lines and anti – stokes lines, explanation of Raman spectra based on Einstein theory, Raman frequency, selection rules, application of Raman spectra.

Electronic Spectra: Potential energy (PE) curves, bonding and anti-bonding molecular orbitals, Frank-Condon Principle, selection rules, qualitative description of sigma pi (π) and non-bonding (n) molecular orbitals, their energy levels and respective transitions.

UNIT – II:

i) **Elementary Quantum Mechanics:** Black body radiation, Photo-electric effect, Bohr model of hydrogen atom (no derivation) and its defects, Compton effect, de Broglie hypothesis, Heisenberg Uncertainity Principle, operators and observable, Hamiltonian operator; Schrodinger wave equation and its importance; physical significance of wave function; postulates of quantum mechanics, quantum numbers and their importance; hydrogen atom - like wave functions, angular wave functions.

ii) **Molecular Orbital Theory(MOT):** criteria for forming molecular orbitals (MO) from atomic orbitals (AO), construction of MOs using LCAO – hydrogen molecular ion, calculation of energy levels from wave functions; physical picture of bonding and anti-bonding wave functions; concept of σ, $\sigma*$, π, π^* orbitals and their characteristics; hybrid orbitals – sp, sp^2, sp^3, sp^3d, d^2sp^3 hybridization, calculation of coefficient of Aos used in these hybrid orbitals, comparison of MOT and VBT (valence bond theory); Geometry of simple molecules like H_2O, NH_3, CH_4, H_2O_2 in terms of molecular orbitals.

iii) **Statistical thermodynamics:** Limitation of classical thermodynamics, brief resume of the concept of of distribution of energy; thermodynamic probability and entropy; Maxwell distribution law; Maxwell-Boltzmann statistics, Bose-Einstein Statictics; Fermi-Dirac statistics.

Partition function and its physical significance – translational, rotational, vibrational and electronic partition functions; relationship between thermodynamic functions and partition functions; Sackur Tetrode equation.

Thermodynamic functions in terms of partition functions; thermodynamic properties of ideal monoatomic gas; partition function of a real gas; equilibrium constant of an ideal gas reaction in terms of partition function; heat capacity of solids.

UNIT – III:

i) Phase equilibrium: phase, component, degree of freedom, phase rule equation: P + F = C + 2 and its thermodynamic derivation.

One Component Systems – water, carbon dioxide, sulphur system.
Two Component Systems - salt solutions: KI – water; Fe_2Cl_6 – water systems, salt hydrate – $CuSO_4.5H_2O$.
Binary alloys: antimony – lead; aluminium – magnesium; gold – tin systems.
Liquid – liquid mixture: Phenol – water, water – triethyl amine; water – nicotine; their miscibility; steamdistillation, fractional crystallization; zone refining; partial miscibility of solid and liquid solutions.
Thermal analysis, cooling curves, eutectic points, different alloys.

ii) **Macromolecules:** Definition, types of macromolecules, degree of polymerization, molar mass – number – average and weight – average molar mass – distribution of molar mass – determination of molar mass by viscometry; osmometry; light – scattering; ultra – centrifuge and diffusion methods.
Types of polymerization reactions – mechanism – kinetics of polymerization reactions; initiators – types functions.
Conformation and configuration of macromolecules in solution.

Crystallinity of macromolecules – factors influencing crystallinity; experimental determination of crystallinity of polymers. Properties of macromolecules, their uses.

B.SC CHEMISTRY (HONOURS) PART-III SYALLABUS
Paper-VIB (Industrial Chemistry, Theoretical): 50 Marks
Total Units: Three

Question Pattern

a.One Compulsory question (Q.No.1) is to be set with nine (short/ multiple choice/ both) questions of 1 mark each from three units, of which five are to be answered.
b.Two questions of 15 marks each are to be set from each unit, out of which one question is to be answered . Each question of 15 marks may be divided into three or more parts having a maximum of 8 marks for a part.

UNIT – IA: FUELS AND PETROCHEMICALS:

Introduction to fuels, classification of fuels, calorific value of fuels, advantages and disadvantages of different types of fuels, **Coal:** Origin, composition and economic importance of coal, carbonization and gasification, coal tar based chemicals and their importance, carcinogenic chemicals.**Gaseous fuels:** Origin, composition, refining, reforming, fractionation and cracking of petroleum, gasoline, petrol, kerosene, naphtha, liquid petroleum gas (LPG), flash point, octane number, cetane number, knocking, anti-knocking compounds. Synthetic petrol, Fischer Tropsch process, Begius process, petroleum extraction in India.

Petrochemicals: Large scale preparation and uses of the following petrochermicals, butadiene, isoprene, acrylonitrile, caprolactam, dimethyl terephthalate, styrene, maleic anhydride, vinyl acetate, ethylene oxide. Economic importance of petrochemicals with special reference to India. Prospects of petrochemical industries in Tripura and other eastern states.

UNIT – IB: FATS & OILS, SOAPS AND DETERGENTS AND COSMETICS

i) **Fats and oils:** Natural fats, edible and industrial oils of vegetative origin, classification based on drying property, evaluation of quality of oils – acid value, manufacture of vanaspati, margarine.

ii) **Soap and detergent:** Washing and toilet soaps, preparation and uses, synthetic detergents – alkyl and aryl sulphonates, fatty alcohol sulphonates, ethanolamines, nonionic detergents.

iii) **Cosmetics:** Preparation and uses of the following cosmetics: Hair dyes, face creams, lipsticks, talcum powder, nail polish, shampoo, hazards of cosmetics.

UNIT – IIA: FERMENTATION INDUSTRIES, PHARMACEUTICALS AND FOOD ADDITIVES

i) **Fermentation industries:** manufacture of ethyl alcohol, citric acid and lactic acid. Manufacture of sugar from sugar cane and sugar beet, uses of by-products.

ii) **Pharmaceuticals:** Relation between chemical structure and physiological activity approached for drug design, preparation and uses of the following drugs – novalgin, diazepam, paracetamol, primaquine, phenobarbitol and sulphadiazine.

ii) Food additives: A general study of food flavours, food preservatives, food colours, artificial sweetner. Food adulteration – its impact on public health.

UNIT – IIB: WATER AND SOME LARGE SCALE USED HAZARDOUS CHEMICALS

i) **Water conditioning:** Classification and modern methods – ion exchange, electrodyalysis, reverse osmosis, chlorination and fluorination.

ii) **Water pollutants:** Classification, sources – fertilizes, pesticides, detergents, industrial wastes, radioactive materials, adverse effects.Measurement of BOD and hardness in water, quality measurement of water.

iii) **Heavy chemicals:** Manufacture, application and hazards of HCl, H_2SO_4, HNO_3, H_3PO_4, hydrazine, bleaching powder.

UNIT – IIIA: FERTILIZERS AND USEFUL INORGANIC MATERIALS

i) **Fertilizers:** manufacture and uses of ammonium fertilizers, urea, phosphate and superphosphates, fixation of atmospheric nitrogen, important fertilizer industries in India.

ii) **Glasses:** Types, composition and properties of glass, optic glass, coloured glass, lead glass. Neutron-absorbing glass and fibre glass.

iii) **Ceramics:** Types of cement – their manufacture, chemistry of setting process.

iv) **Silicon:** Production of ultrapure silicon, its uses in electronic industry.

UNIT – IIIB: POLYMERS

i) **Organic polymers:** Types of polymerization process, manufacture and application of natural and synthetic rubber, plastics – polyolefins and polyurethans and synthetic fibres – polyester, polyamide, polyacrylate, silk.

ii) **Inorganic polymers:** Comparison between organic and inorganic polymers, types of inorganic polymer, synthesis, structure and application of silicone, phosphonitrilic halides and condensed phosphates.

B. SC PART-III (HONOURS) PRACTICAL SYLLABUS
Paper-VII (Group-A: Organic& Inorganic) Marks: 50 Marks
Time : 06 hours

Group-A: Organic Chemistry - 50 Marks (Time: 6 hours)
Group-B: Inorganic chemistry - 50 Marks (Time: 6 hours)

Group-A: Organic Chemistry:
Distribution of Marks:

1. Organic qualitative analysis : 40 Marks
2. Laboratory Note Books : 05 Marks
3. Viva-voce – 05 Marks

Organic Qualitative analysis: Identification of the following organic compounds through systematic analysis (determination of mp, solubility test, detection of special elements, detection of functional groups, preparation of suitable derivative, determination of R_f value on TLC and survey of literature)
List of compounds to be identified: Cinnamic acid, succinic acid, salicylic acid, p-hydroxy benzoic acid, o-chlorobenzoic acid, phthalic acid, benzamide, phthalimide, benzanilide, acetanilide, benzil, benzophenone, glucose, vaniline, antharacene, diphenyl, urea.

Group-B: Inorganic chemistry
Distribution of Marks:

1. Inorganic quantitative estimation : 30 Marks
2. Inorganic preparation: 10 Marks
3. Laboratory Note Books : 05 Marks
4. Viva-voce – 05 Marks

Inorganic quantitative estimation:
1A. Quantitative titrimetric estimation of both the metal ions from their mixture:

i) Iron & Copper
ii) Iron & Chromium
iii) Iron & Calcium
iv) Copper & Zinc

1B.**Quantitative estimation of metal ion volumetrically and acid radical gravimetrically:**

i) Copper sulphate
ii) Ferric chloride

2. **Preparation of Inorganic Compounds:**

List of Inorganic compounds to be prepared:

i) Tetramine copper (II) sulphate
ii) Potassium trisoxalato chromiate (III)
iii) Hexamine cobalt(III) chloride
iv) Common alum
v) Bis-(dimethylglyoxamato)nickelate (II)
vi) Potassium trisoxalato ferrate (III)

B. SC PART-III (HONOURS) PRACTICAL SYLLABUS
Paper-VIII Marks: 100 Marks
Time : 12 hours

Group-A: Physical chemistry practical: 50 Marks (Time: 6 hours)
Group-B: Industrial chemistry practical: 30 Marks (Time: 3 hours)
Group-C: Project/Seminar : 20 Marks (Time: 3 hours)

Distribution of marks:
Group-A:

1. Experiment (one)-40 Marks
2. Laboratory note book-05 Marks
3. Viva-voce – 05 Marks

List of experiments to be performed:

1. Determination of the concentration of a supplied solution by surface tension method using stalagmometer.
2. Determination of the concentration of a supplied solution by viscosity method using Ostwald viscometer
3. Determination of partition coefficient of benzoic acid between benzene and water and dimerization constant of benzoic acid in benzene.
4. Potentiometric titration of Fe^{2+} with dichromate and determination of E^0 and of concentration of unknown iron solution.
5. Verification of Freundlich's adsorption isotherm by study of the adsorption of acetic acid solution on activated charcoal and determination of concentration of acetic acid of unknown strength.
6. Determination of concentration of supplied silver nitrate solution by standard KCl solution or supplied $BaCl_2$ by standard Na_2SO_4/K_2SO_4 conductometrically.
7. Verification of Beer's law and determination of concentration of supplied dichromate solution.
8. Determination of equilibrium constant of the equation, $KI + I_2 = KI_3$ in aqueous solution.
9. Determination of the rate constant of acid catalyzed hydrolysis of ethyl acetate or other ester at room temperature.
10. Determination of specific rotation of cane sugar solution using polarimeter

Group B: Industrial chemistry practical

Distribution of marks:

1. Experiment (one) : 20 Marks
2. Laboratory Note Book : 05
3. Viva-voce : 05

List of the experiments to be performed:

1. Estimation of total hardness of a supplied water sample.
2. Estimation of the amount of iron present in a supplied cement sample.
3. Determination of saponification value of a supplied vegetable oil/ester.
4. Determination of iodine value of a supplied vegetable oil/unsaturated ester.
5. Determination of chemical oxygen demand(COD) of a supplied water sample
6. Determination of available chlorine in supplied bleaching powder.

Project work/Seminar

The topic of the project or seminar to be decided by the teachers of the college based on the facilities available as well as on the course work or on the science related problems of the society.

RECOMMENDED BOOKS

Organic Chemistry(Pass):

1. Org. Chemistry, I.L. Finar, Vol. I, 6th Edn. ELBS
2. Advanced Org. Chemistry, B.S. Bahl & A. Bahl, S. Chand
3. Advanced Org. Chemistry, Reactions & Mechanism, Mukherjee & Singh,
4. Org. Chemistry, R.T. Morison & R.N. Boyed, Prentice – Hall.
5. Stereochemistry of Carbon Compounds, D. Nashipuri, John Wiley
6. Basic stereochemistry of organic molecules, Subrata Sengupta, Book Syndicate
7. Advanced organic chemistry, N.K. Visnoi
8. Jaiba Rasayan, Subrata Sengupta, Book Syndicate.

Inorganic Chemistry(Pass):

1. Inorganic Chemistry Vol. I & II, R.L. Datta
2. Advanced Inorganic Chemistry Vol. I & II, Prakash, Tuli, Basu and Madan, S. Chand
3. Fundamental concepts of Inorganic Chemistry, A.K. Das
4. General and Inorganic Chemistry, R. P. Sarkar, Central…
5. A manual of practical chemistry, R.C. Bhattacharjee
6. General and inorganic chemistry, S.N. Podder & S.P. Ghosh

Physical Chemistry(Pass):

1. Bhouta Rasayan, N.N.Kundu, Vol. I & II
2. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand
3. Bhouta Rasayan, P.C. Rakshit & P.R. Gupta, Sarat Book House.
4. Elementary Physical Chemistry, S.R. Palit, Syndicate Pvt. Ltd.
5. University hand book of undergraduate chemistry experiments, G.N. Mukherjee, University of Calcutta.
6. College practical chemistry, Ahluwalia, Dingra & Gulati.

Organic Chemistry(Honours):

1. Org. Chemistry, I.L. Finar, Vol. I, 6^{th} Edn. ELBS
2. Advanced Org. Chemistry, J. March
3. A guide to Org. Reaction Mechanism, P. Sykes, Orient Longmen.
4. Org. Chemistry, R.T. Morison & R.N. Boyed, Prentice – Hall.
5. Fundamentals of Org. Chemistry, Solomn
6. Org. Chemistry, Wade (Jr)
7. Stereochemistry of Carbon Compounds, E. Eliel.
8. Stereochemistry of Carbon Compounds, D. Nashipuri, John Wiley
9. Org. Spectroscopy, Y.R. Sharma
10. Org. Spectroscopy, W. Kemp
11. Org. Spectroscopy, P.S. Kalshi
12. Org. Reaction Mechanism, P.S. Kalshi
13. Org. Reaction mechanism, R.K. Bansal
14. Hand book of Org. analysis – qualitative & quantitative, H.D. Clarke
15. Advanced organic chemistry, N.K. Visnoi
16. Advanced practical chemistry, R. Mukhopadhaya & P. Chatterjee.
17. Advanced organic chemistry, Miller

Inorganic Chemistry(Honours):

1. Basic inorganic chemistry, F.A. Cotton & G. Wilkinson & Gous
2. New concise inorganic chemistry, J.D. Lee
3. Inorganic Chemistry, Huheey, Keitar & Medhi
4. Selected topics in inorganic chemistry
5. Inorganic Chemistry, Sharpe
6. Inorganic chemistry, W.W. Porterfield
7. Introduction to modern inorganic Chemitry, Mackay & Mackay
8. Vogel's qualitative inorganic analysis, G. Svehla
9. Qualitative analysis, V. Alexeyev
10. Elements of Bioinorganic Chemistry , G.N. Nukherjee & A. das

Physical Chemistry(Honours):

1. Physical Chemistry, P.C. Rakshit
2. Physical Chemistry, P.W. Atkins
3. Physical Chemistry, G. W. Castellan
4. Physical Chemistry, S. Glastone
5. Physical Chemistry, Marron & Pruton/ Marron & Lando
6. Molecular spectroscopy, Barrow
7. Molecular spectroscopy, Banwel