TRIPURA UNIVERSITY
(A Central University)
Suryamaninagar-799022

Syllabus

For

B.Sc. Honours Course

CHEMISTRY (Elective &Honours)
2014

STRUCTUE OF SYLLABUS:

1. In each course/paper of 80 marks shall be 4 distinct units.
2. In each of paper/course of 40 marks there shall be 2 distinct units.

DURATION OF EXAMINATION:

1. For paper of 80 marks	3 hours	(General and Major)
2. For paper of 40 marks	2 hours	(General and Major)

QUESTION PATTERN:

A. Papers/Course having forty (40) marks:-

1. Three (3) questions will be set from each unit out of which two (2) questions of 10 marks each are to be answered.
2. Each question of ten (10) marks may be subdivided into 2 to 3 marks having maximum of 5 marks for a part.

B. Papers/Course having eighty (80) marks:-

1. Three (3) questions will be set from each unit out of which two (2) questions of 10 marks each are to be answered.
2. Each question of ten (10) marks may be subdivided into 2 to 3 marks having maximum of 5 marks for a part.

C. Papers/Course having sixty (60) marks:-

1. Out of sixty (60) marks twelve (12) marks will be for Internal Assessment.
2. Remaining forty-eight (48) marks are to be divided into 2 units each of which will comprise twenty four (24) marks
3. In each of the aforesaid unit there will be three (3) questions out of which two (2) questions of twelve (12) marks each are to be answered.
4. Each question of twelve (12) marks may be subdivided into 2 to 3 marks having maximum of 5 marks for a part.

D. There will be no MCQ type of questions in Honours papers and in case of General Courses the papers having practical component also there will be no MCQ type question.

B.Sc. SUBJECTWISE MARKS DISTRIBUTION

Semester	Paper	Marks	Semester	Paper	Marks
S1	C1P1	100	S2	C1P2	50+50(Pr)
	C2P1	100		C2P2	50+50(Pr)
	C3P1	100		C3P2	50+50(Pr)
	FNDC (English)	100		FN (MIL) +HAC	100
S3	C1P3	50+50(Pr)	S4	C1P4	50+50(Pr)
	C2P3	50+50(Pr)		C2P4	50+50(Pr)
	C3P3	50+50(Pr)		C3P4	50+50(Pr)
	EVS	100		Computer Skill	
S5	C1P5	50+50(Pr)	S6	Project	100
	C2P5	50+50(Pr)		NER Studies	100
	C3P5	50+50(Pr)		Entrepreneurship Development	100
	Constitution of	100		Human Rights &	100

	India & Planning			Gender Studies	

B.Sc. Honours

SEM-I	SEM-II	SEM-III	SEM-IV	SEM-V	SEM-VI
Eng	MIL	EVS	Computer	H5	H7
C1P1	C1P2	C1P3[50+50(Pr)]	C1P4[50+50(Pr)]	H6[00(Pr)]	H8[100(Pr)]
C2P1	C2P2	C2P3[50+50(Pr)]	C2P4[50+50(Pr)]	Constitution & Planning	Project
H1(100)	H2[60+40(Pr)]	H3[60+40(Pr)]	H4[60+40(Pr)]	C1P5 [50+50(Pr)]	Human Rights & Gender Studies
				C2P5 [50+50(Pr)]	

SEMESTER WISE MARKS DISTRIBUTION

Semester	General Programme	Major Programme
I	400	400
II	400	400
III	400	400
IV	400	400
V	400	500
VI	400	500
Total (I to VI)	**2400**	**2600**

B.Sc. Honours, Semester – I
Subject: Chemistry
Paper – H1,
Marks:100 (80+20)

Unit-I General Chemistry (Marks:20) 30 Lectures

A. Atomic Structure: Limitations of Bohr's atomic model; idea of the de Broglie matter waves, Heisenberg's uncertainty principle; Schrodinger's wave equation and its importance; quantum numbers; concept of wave function; physical concepts of Ψ and Ψ^2; radial and angular wave functions; shapes of s, p and d-orbitals, Aufbau principle, Pauli's Exclusion Principle, Hund's rule, Variation of orbital energies with atomic number and energy level diagram, electronic configurations of atoms, screening effect and effective nuclear charge, extra stability of half-filled and completely filled orbitals.

B. Periodic properties: Modern periodic table, classification of elements on the basis of electronic configuration; periodic variation in properties – atomic and ionic radii, oxidation states, ionization potential, electron affinity, electronegativity (Mulliken scale, Pauling's scale and Allen Rochow scale); diagonal relationship.

Unit-II: Inorganic Chemistry (Marks:20) 30 Lectures

A. Redox Reactions: Ion electron method of balancing equations, calculation of equivalent Weights of oxidants and reductants, standard electrode potential, formal potential, electrochemical series; redox potentials and its applications, choice of indicators in redox titrations.

B. Chemical Bonding:

Ionic Bonding: Types of ionic solids; radius ratio effect; limitation of radius ratio rule; concept of lattice energy, Bond-Lande equation; Born-Haber cycle; solvation energy and solubility of ionic solids; ionic potential, polarizing power; polarizability of ions and Fajan's rule.

Covalent Bonding: Basic idea of valence bond theory and its limitations; Concept ofhybridization of orbitals; Bent's rule; valence shell electron pair repulsion (VSEPR) theory and its application to shapes of molecules and ions: BeF_2, BF_3, H_3O^+, NH_3, NH_4^+, ICl_2^+, H_2O, PCl_3, PCl_5, SF_4, SF_6, XeF_2, XeF_4, XeF_6, $XeOF_4$, ClF_3; formal charge, polarity of covalent bonds and dipole moment, percentage of ionic character of covalent bond, LCAO-MO theory and its application to homonuclear (H_2, N_2, O_2, O_2^{2-}, O_2^-, O^{2+}); heteronuclear diatomic molecules (CO, NO, HF) and polyatomic molecules (BeH_2, H_2O, NH_3).

Bonding in Metals, Semiconductors and Hydrogen Bond: Qualitative idea of free electron theory and band theory in solids; elementary ideas on semiconductors (n and p

types); hydrogen bonding – concept and types of H-bonding – application to inorganic molecules, van der Waal's forces, π-π and C(H)-π interactions.

Unit-III:Organic Chemistry; (Marks:20); 30 Lectures

A. Structure, Reactivity in Organic Molecules:

Hybridization(sp^n,n= 1,2,3) of organic compounds, 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 , resonance, tautomerism, 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. Activation energy and Transition state. Energy profile diagrams for reactions with single or multiple steps. Concepts of kinetic and thermodynamic control.

B. Organic reaction mechanism in aliphatic compounds

Alkanes, Corey-House synthesis of alkanes ; Synthesis of alkenes, alkynes and alkadienes. synthesis (preparation)of alcohols and ethers, aldehydes and ketones, carboxylic acids and their derivatives, alkyl nitrates , nitro alkanes , nitriles , amines. 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) Elimination reactions - α and β –eliminations , *syn* – and *anti*-elimination ; E_1 and E_2- mechanism.

C. Important reactions with mechanism of aliphatic compounds

Alkane: free radical halogenations, Alkenes: halogenation, hydroxylation, hydrogen halides, ozonolysis, hydroboration-oxidation, woodward-prevost hydroxylation, oxymercuration, catalytic hydrogenation of alkenes. Alkadienes: conjugated addition; 1,2vs 1,4- additions. Alkynes: acidity, use of Lindlar's catalyst, Birch reduction; hydration. Alcohols: dehydration, oxidation, pinacol-pinacolone rearrangement, carbonyls: Oppenauer oxidation, MPV reduction, Rosenmund reduction, Stephen's reaction, Sommelet reaction, Baeyer-Villiger oxidation, Wolff-Kishner reduction; Aldol, Claisen and Darzen-glycidic ester condensation; Cannizzaro and Tischenko reactions.

Unit-IV: Physical Chemistry; (Marks:20); 30 Lectures

A. The Gaseous state: (12 Lectures)

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'sexperiments 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).

B. Crystalline state: (10 Lectures)

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 (XRD) 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, colour center, semi- conductors.

C. Fundamentals of computer: (8 Lectures)

History of development of computers, computer systems (mainframe, minis, micros and super computers); general awareness of computer hardware i.e. CPU and other peripheral devices (Input/Output and auxiliary storage devices); block diagram of computer; representation of characters, integers in computers (Bit, Byte, Word) and conversions – decimal to binary, decimal to hexadecimal; introduction to computer software (system & application); introduction to computer languages; introduction to computer programming; basic knowledge of computer programming in BASIC.

B.Sc. Honours, Semester – II
Subject: Chemistry
Paper – H2, (A)
Marks:60 (48+12)

Unit-I: Inorganic Chemistry (Marks:24) 36 Lectures

A. ***Acid-Base Concept***: Arrehenius and Bronsted-Lowry concept, the solvent-system concept (Franklin) and its limitations; Lewis concept; SHAB principle; pH and pH scale; effect of solvent on relative strengths of acids and bases – leveling effect; Relative strengths of acids and bases (pKaand pK_b concept).

B. ***s-Block Elements:***Group discussion of the elements with respect to position in the periodic table: electronic configuration, atomic and ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy), electronegativity, oxidation states, variation in properties of oxides and hydroxide, solvation and complexation tendencies of alkali and alkaline earth metals. Chemistry of lithium and beryllium their anomalous behavior and diagonal relationship.

C. ***Noble Gas:***Preparation, properties and structure of xenon oxides, fluorides, oxyfluorides.

D. ***p-Block Elements:*** Group discussion of the elements with respect to position in the periodic table: electronic configuration, atomic and ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy), electronegativity, oxidation states, variation of acidic and basic properties of their oxides and oxy-acids, inert pair effect and catenation.

Preparation, properties and structure in the following compounds:Diborane (with emphasis on bonding), Carbides, Hydrazine, hydroxylamine, hydrazoic acid, oxy acids of nitrogen, sulphur and halogens; per acids and salts of carbon and sulphur; interhalogen compounds, Pseudo-halogens, polyhalides, basic properties of Iodine. Sodium thiosulphate, Sodium dithionite, potassium iodide, boric acid, lithium aluminium hydride,lead tetraacetate.

Unit-II:Organic Chemistry; (Marks:24); 36 Lectures

A. Stereochemistry of organic compounds

Types of stereoisomers – configurational and conformational, enantiomers and diastereomers, geometrical and pi-diastereomers and their nomenclatures, difference in chemical and physical properties of pi-diastereomers, optical isomers, chirality, asymmetry, dissymmetry, R/S and D/L notations of optical isomers, raceimic mixture and resolution.

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 monosubstitutedcyclohexanes; stability of cycloalkanes-strains in rings, angle strain and torsional strain , Baeyer strain theory and its limitations. Asymmetric synthesis: stereospecific and stereoselective synthesis, regioselectivie synthesis, application of cram's rule, prelog's rule and Ahn-Felken rule.

B. Aromatic compounds

Aromaticity, non aromatic, antiaromatic, homoaromatic (benzenoid and nonbenzenoid). Preparation and properties of benzene, naphthalene, anthracene and phenanthrene.

C. Organic reaction mechanism in aromatic compounds

Electrophilic substitution in benzene (general mechanism): alkylation, acylation, halogenations, nitration, sulphonation. Synthesis and reactions of arenes, aromatic alcohols, aromatic halides, phenols, carbonyls, quinones, amines, nitrocompounds, carboxylic acids and name reactions of these compounds.

B.Sc. Honours, Semester – II
Subject: Chemistry
Paper – H2, (B)
Marks:40 (32+08)
Time: 6 hours

A. Inorganic Qualitative Analysis: Marks:32

Experiment for 5 radicals	=24
Practical Note Book	=03
Viva-Voce	=05

[Qualitative analysis of mixtures of inorganic salts containing not more than **five** radicals (at least one interfering radical) from the following list]:

Basic Radicals: Silver, lead, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, chromium, manganese, cobalt, zinc, nickel, calcium, barium, strontium, magnesium, potassium, ammonium.
Acid Radicals: 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. Internal Assessment: Marks:08

B.Sc. Honours, Semester – III
Subject: Chemistry
Paper – H3, (A)
Marks:60 (48+12)

Unit-I: Inorganic Chemistry (Marks:24) 36 Lectures

Coordination Compounds: Werner's Coordination theory, coordination number, ligands and their classification, chelation,chelate effect and its applications; nomenclature of coordination compounds, isomerism in coordination compounds, stereoisomerism: geometrical and optical isomerism in 4- and 6-coordinate complexes; innermetallic complexes; stabilization of unusual oxidation states;Sidgwick's effective atomic number rule.

Bonding in transition metal complexes:Valence bond theory (VBT) and Crystal Field Theory (CFT) for octahedral, tetrahedral and square planer complexes; Explanation of magnetic properties, structures and colour of coordination complexes on the basis of the above theories; Nephelauxetic effect, elementary idea of adjusted crystal field theory (ACFT).

Magnetochemistry:Concept of diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, Origin of paramagnetic moment: electron spin moment and orbital angular

moment, magnetic susceptibility and magnetic moment;magneticsusceptibility measurement by Gouymethods.Curie law, Curie-Weiss law, explanation of magnetic behaviour of$K_4[Fe(CN)_6]$, $K_3[Fe(CN)_6]$, $[Co(NH_3)_6]Cl_3$, $K_3[CoF_6]$, $K_2[Ni(CN)_4]$, $Ni(CO)_4$.

Unit-II: Physical Chemistry; (Marks:24); 36 Lectures

A. Thermodynamics and Kinetics (16 Lectures)

Thermodynamic systems- 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'sexperiment, 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 and their comparisons.

B. The Liquid State and Solution Properties: (12 Lectures)

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'slaw.

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.

C.Physical properties: (8 Lectures)

Additive and constitutive properties- molar volume at boiling point, parachor, rheochor, molar refraction, 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-ClausiusMosotti equation, Debye equation, experimental methods for the determination of dipole moment, magnetic properties;

paramagnetism, diamagnetism and ferromagnetism. Ascertaining structure of molecules using above properties.

B.Sc. Honours, Semester – III
Subject: Chemistry (Practical)
(Organic Chemistry)
Paper – H3, (B)
Marks: 40 (32+08)
Time: 6 hours

Experiment	=24
Practical Note Book	=03
Viva-Voce	=05

A. Organic qualitative analysis: Marks:32

Identification of a pure solid organic compound through detection of special elements (nitrogen, sulphur, halogens) and functional groups (phenolic-OH, -COOH, -CHO, >CO, -NH_2, -NO_2, -$CONH_2$, >C=C<). (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). No need to write detail analytical methods, observations instead total analytical data should be submitted in the given format to be supplied in the examination.

List of compounds to be identified: Adipic acid, Cinnamic acid, succinic acid, benzoic acid, salicylic acid, o-chlorobenzoic acid, benzamide, phthalimide, benzil, benzoin, p-nitro benzoic acid, 4-hydroxy benzoic acid, benzophenone, glucose, urea, Sulphanilic acid, p-nitroaniline, □-napthyl amine, resorcinol, □-napthol, hydroquinol, anthranilic acid

B. **Internal Assessment: Marks:08**

B.Sc. Honours, Semester – IV
Subject: Chemistry
Paper – H4, (A)
Marks:60 (48+12)
Time:2 hours

Unit-I: Organic Chemistry (Marks:24) **36 Lectures**

A. Reactive intermediates: (12 lectures)
Carbocations, Carbanions, carbenes (electrophilic and nucleophilic) ,arynes and nitrenes – synthesis, stability, structure and reactivity.

B. Synthetic applications of active methylene compounds and organometallic reagents: 12 lectures
Synthesis and synthetic applications of diethyl malonate and ethyl acetoacetate; Preparation and synthetic applications of Grignard reagents, Organolithium and Organocopper reagents

C. Rearrangements reaction: (12 lectures)

Pinacol-pinacolone, Dienone-phenol, Wagner-Meerwein, Beckmann, Wolff, Hoffmann, Curtius, Lossen, Schmidt, benzil-benzilic acid, Favorskii, Fries and Claisen, Demjenov.

Unit-II: Physical Chemistry (Marks:24) 36 Lectures

A.**Second law of thermodynamics: (8 Lectures)**

Need for the law, spontaneous process, statements 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).

B. Chemical equilibrium: (8 Lectures)

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 Kp, Kcand Kx, Reaction isotherm, reaction isochore, Van't Hoff equation, equilibrium in phases –Clapeyron equation, Clausius – Clapeyron equation.

C.Electrochemistry-I (12 Lectures)

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 (no derivation); activity and activity co-efficient; application of conductance measurements – conductometric titrations, solubility of sparingly soluble salts

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

D.Phase equilibrium: (8 Lectures)

Phase, component, degree of freedom, phase rule equation: F = C-P + 2 and its thermodynamic derivation.One Component Systems – water, carbon dioxide, sulphursystem.Two Component Systems - salt solutions: KI – water; Fe_2Cl_6– water systems, salt hydrate – $CuSO_4$.5H2O.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.

B.Sc. Honours, Semester – IV
Subject: Chemistry (Practical)
(Physical Chemistry)
Paper – H4, (B)
Marks:40 (32+08)
Time:4 hours

A. Physical Experiments: **Marks:32**

Experiment:	24 Marks
Laboratory Note Books :	03 Marks
Viva-voce:	05 Marks

The following experiments are to be performed by the students.

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'sviscometer.
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. Conductometric Titration of Strong Acid(HCl) vs Strong Base(NaOH)
7. Conductometric Titration of Weak Acid(CH_3COOH) vs Strong Base(NaOH)

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.

B. Internal assessment: **Marks:08**

B.Sc. Honours, Semester – V
Subject: Chemistry
Paper – H5,
Marks:100 (80+20)
Time:3 hours

Group A:Inorganic Chemistry (Marks:40) 60 lectures
Unit I: Inorganic Chemistry (Marks:20) 30 Lectures

d- and f-Block ElementsElectronic configuration of d-block elements, general properties of transition metals, relative stability of oxidation states, comparison of properties of first, second and third row transition metals. Electronic configurations of lanthanides and actinides,

comparison of their oxidations states; variation in their atomic and ionic radii – lanthanide contraction, difficulty in the separation of lanthanides and ion exchange method of separation. Preparation, important reactions, structures and uses of nickel tetracarbonyl, Sodium nitroprusside, sodium cobaltinitrite, potassium ferrocyanide, potassium ferricyanide, potassium dichromate, potassium permanganate, cupric acetate, uranyl nitrate hexahydrate, uranium hexafluoride and Ziese's salt.

Nuclear and Radio-chemistry: Nuclear particles;neutron-proton ratio and its implications, types of radioactive decay; nuclear binding energy; mass defect andpacking fraction; natural and artificial radioactivity; first orderrate equation of radioactive disintegration;radioactive equilibrium; radioactive disintegration series; half-life and average life period, group displacementlaw, unit of radioactivity; carbon-14 dating, types of nuclear reactions, concepts of fusion and fission, spontaneous fission, Q value; nuclear forces: n-n, n-p, p-p.

Unit-II: Inorganic Chemistry: (Marks:20) 30 Lectures

Organometallic 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, 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 pentahaptocyclopentadienyl 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).

Bioinorganic Chemistry:Structure of cell membrane, membrane transport (active and passive transport process); essential and trace elements in biological processes, criteria of essential elements, pH of biological fluid, metalloporphyrins, structure, and functions of haemoglobin, myoglobin and chlorophyll; role of Fe and Mg in haemoglobin and chlorophyll, role of Co in vitamin B_{12}, Carbonic anhydrase, its characteristics and functions,. Non-complexingcations in biochemical processes, Na^+-K^+pump; Toxic effects of metal ions with reference to mercury, lead, beryllium and aluminum; deficiency of Fe, Ca, Mg and iodine; Platinum complexes as anti-cancer drugs.

Statistical treatment of data analysis: Accuracy and precision, classification of errors, detection and correction of determinant and indeterminant errors; the normal law of distribution of indetermination errors; the F and T tests, rejection of data, methods of least squares, propagation of errors in computation, significant figures.

Group B: Organic Chemistry (Marks: 40) 60 Lectures

Unit – III **(Marks: 20) 30 Lectures**

A. Heterocyclic compounds: 10 Lectures

Introduction, five and six membered heterocycles, aromatic character, nomenclature, structure, synthesis and chemical reactivity of furan, pyrrole, thiophene, pyridine and basicity of pyrrole and pyridine; 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 BischlerNapieralsky synthesis.

B. Carbohydrates: 10 Lectures

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.

C. Amino acids and Proteins: 10 Lectures

Introduction, alpha-amino acids – synthesis, physical and chemical properties, iso-electric points, peptide synthesis, protection and de-protection strategies involved in peptide synthesis; determination of C and N terminal amino acid residues; proteins classification, primary, secondary, teriary and quaternary structure of proteins (definations only) and chemical test of proteins.

Unit – IV (Marks:20) 30 Lectures

A. Pericyclic & Photochemical Reactions: 10 lectures

Definition and classification, electrocyclic reactions: FMO approach, example of electrocyclic reactions (thermal and photochemical) involving 4□ and 6□ 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.

B. SPECTROSCOPY 10 lectures

Ultraviolet and Visible spectroscopy: Introduction, theory, instrumentation and solvent effects, characteristic absorption of organic compounds, application of rules for calculation of $\square_{max}$polyenes and dienones.

Infrared Spectroscopy: Introduction, theory, instrumentation, characteristic group frequencies of organic molecules, factors affecting group frequencies.
Proton NMR spectroscopy: Introduction, theory, deuterated solvents, 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.

C. Chemistry in applications: 10 lectures

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.
Drugs and pesticides: Introduction, classification of drugs, preparation and uses of aspirin, phenacetin, sulphanilamide, sulphaguanidine, diazepam. Introduction and Classification of pesticides, natural and synthetic pesticides, preparation and uses of DDT, endrin, melathion, parathion and baygon,

B.Sc. Honours, Semester – V
Subject: Chemistry (Practical)
Paper – H6,
Marks: 100 (80+20)

A. Inorganic Chemistry Practical (40 Marks) Time: 3 hours

Volumetric titrations: Marks 12
Quantitative analysis: Marks: 12
Inorganic preparation & Crystallization: Marks: 06
Laboratory note book: Marks:05
Viva Voce: Marks: 05

(a)**Volumetric titrations:**
i) Estimation of Fe^{+2}/Ca^{+2} by EDTA
ii) Estimation of Cu^{+2}/Fe^{+2} by iodometric method
iii) Estimation of CO_3^{-2} + HCO_3^{-1} in a mixture
iv) Estimation of total hardness of water samples

(b) Quantitative analysis
i) Estimation of Nickel(II) using DMG
ii) Estimation of $SO_4^{-2}$by using $BaCl_2$method
iii) Estimation of percentage of mixed oxide in an ore Hematite, dolomite, limestone.

(c) Inorganic preparation &Crystallization:
i) Tris (thiourea) Copper (I) Sulphate
ii) Hexamine Cobalt (III) Chloride
iii) Chloropenta amine Cobalt III Chloride
iv)Potassium tri(oxalate) Chromate (III)

vi)Potassium tri(oxalate) Ferrate (III)
vii) Sodium peroxoborate
viii) Tris(acetylacetanoto) Iron(III)
ix)Sodium cobaltinitrite

B. Organic Chemistry Practical (40 Marks) Time: 3 hours

Organic quantitative analysis:	Marks:20
Organiccompound preparation:	Marks: 10
Laboratory note book :	Marks:05
Viva Voce :	Marks:05

i) Organic quantitative analysis:
   a) Estimation of glycine (Sorenson's method)
   b) Estimation of aniline (bromate-bromide method)
   c) Estimation of oxalic acid (titrimetric method)

ii) Organic Preparation
   a) 7-Hydorxy-4-methyl coumarin
   b) P-Benzoquinone
   c) Benzimidazole
   d) Phthilimide
   e) Benzilic acid from benzil

B.Sc. Honours, Semester – VI
Subject: Chemistry
Paper – H7,
Marks: 100 (80+20)
Time: 3 hours

Physical Chemistry (Marks:40) 60 Lectures
Unit-I: (Marks:20) 30 Lectures

A.ELECTROCHEMISTRY-II (8 Lectures)

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 – Hydrogen electrode,calomel electrode, quinhydrone electrodes, standard electrode potential, electrochemical series, setting up of simple cells, cell reaction, application of e.m.f. measurements – determination of ionic activity, equilibrium constant, potentiometric titration, elementary ideas of polarization and over voltage- Tafel equation (no derivation), successive anodic and cathodic processes, Lead and alkali accumulators.

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

B.Surface properties (8 Lectures)

Adsorption: Absorption vis-à-vis adsorption; types of adsorption; theories of adsorption; Freundlich, Langmuir and Gibb's adsorption isotherms – their derivations; BET equation;

determination of surface area of adsorbates;application adsorption phenomenon in nature and industry.

Catalysis: Classification; criteria for a good catalyst; catalyst promotersand catalyst poisons; theories of catalysis; application of catalyst in the manufacture of ammonia; nitric acid and sulphuric acid; acid base catalysis and enzyme catalysis.

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.Introduction of Nano Particles & Applications

C.Macromolecules: (8 Lectures)

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.

D.Photochemistry: (6 Lectures)

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's law, Beer's law, Lambert – Beer's law, quantum yield and quantum efficiency; photochemical equilibrium; photosensitized reactions ; photosynthesis and photochemistry of air and air pollution;

UNIT – II: (20 Marks) (30 Lectures)

A.Atomic& Molecular Spectra: (10 Lectures)

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

Rotational Spectra - diatomic molecules, energy levels of a rigid rotor, selection rules.

Vibrational Spectra: Hook's law, expression for vibrational energy in terms of quantum number, anharmonicity, fundamental modes of vibration, overtones, Morse curves 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.

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

B.Quantum Mechanics: (10 Lectures)

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; interpretation of wave function.

ii. **Molecular Orbital Theory(MOT):**Criteria for forming molecular orbitals (MO) from atomic orbitals (AO), construction of MOs using LCAO – hydrogen molecular ion; physical picture of bonding and anti-bondingwave functions; concept of σ, σ*, π, π* orbitals and their characteristics;hybrid orbitals – sp, sp^2, sp^3, sp^3d, d^2sp^3hybridization, calculation of coefficient of AOs used in these hybrid orbitals, comparison (in brief) of MOT and VBT (valence bond theory); Geometry of simple molecules like H_2O, NH_3, CH_4, H_2O_2, BF_3in terms of molecular orbitals.

D.Statistical thermodynamics: (10 Lectures)

Limitation of classical thermodynamics, brief resume of the concept of distribution of energy; thermodynamic probability and entropy; Boltzmann distribution law (with derivation), partition function and its significance, translational partition function of ideal monoatomic gas (with derivation). Preliminaries of Maxwell-Boltzmann statistics, Bose-Einstein Statictics and Fermi-Dirac statistics, Thermodynamic functions in terms of partition functions; SackurTetrode equation (with derivation),heat capacity of solids.

Industrial and Green Chemistry (Marks: 40) 60 Lectures

Industrial Chemistry: Inorganic Based: Marks; 10

Water: Modern methods of water treatment and purification.

Fertilisers: Different types of N and P fertilizers, manufacture of ammonia, ammonium nitrate, urea phosphates and superphosphates. Nitrogen fixation by plants.

Glass : Various types of glass fibers, optical glass, glazing and vitrification, glass ceramics.

Cement : Various types of cement, their composition and manufacture. Portland cement, setting of cement

Paints : Constituents of different paints, Role of binder and solvent, Lead and Zinc containing paints. Paints of common use

Metals and Alloys: General procedure of extraction of metals. Manufacture, properties,composition and uses of important alloys. Manufacture of steel and stainless steel.Galvanization, rusting and corrosion.

Chemical Toxicology:

Metal poisoning due to Pb, Cd and Hg, hazard from radioactive fallout. Definitionand principles of green chemistry.

Industrial Chemistry – Organic Based (Marks 10)

Coal: Fisher-Tropsch process. Chemicals from coal.

Petroleum: Manufacture and industrial reactions of ethane, propane, butadiene,acetylene and xylene. Synthesis of methanol from natural gas. Cracking of petroleum, knocking and octane number. Synthetic petrol, LPG and CNG. Biodiesel

Oils, Fats and Detergents: Catalytic hydrogenation of vegetable oil and fat for production of soap, synthesis of detergents. Principles of cleansing action

Polymers:

a. Synthetic rubber (including principle of cross-linking and vulcanization), b. Plastics

c. Resins, d. Silicones

Enzymes in industries: Production of alcohol by fermentation of starch and sugar (reaction conditions, nature of enzymes used, structural transformation during reaction).
Preparation and use of cellulose.

Green Chemistry: (Marks 20)

Definition, Principles of green chemistry, atom economy, environmental factor;Green synthesis (acetylation of primary amines, cycloaddition, benzyl-benzillic acid rearrangement reaction, thiamine catalyzed benzoin condensation, bromination of acetanilide), reaction conditions, solvent free reaction (three components synthesis of dihydropyrimidinone, ammonium formate medited Knoevanagel reaction), sonochemical reaction (Ulman coupling), Use of green reagents (tetrabutyl ammonium tribromide, green oxidizing agents), green catalysts, and green solvents.

B.Sc. Honours, Semester – VI
Subject: Chemistry (Practical)
Paper – H8,
Marks: 100 (80+20)

A. Physical Chemistry Practical (50 Marks); Time: 6 hours

Internal Assessment:	10 Marks
Experiment:	30 Marks
Laboratory Note Books:	05 Marks
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 ammonia between water and an organic solvent.
4. Potentiometric titration of $Fe^{2+}$with dichromate and determination of E^0 $Fe^{3+}/Fe^{+2}$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 mixed acid by standard 0.1(N) NaOHconductometrically.
7. Verification of Beer's law and determination of concentration of supplied dichromate solution.
8. Determination of the rate constant of acid catalyzed hydrolysis of ethyl acetate ester at room temperature.
9. Determination of rate constant of Iodination of Acetone.
10. Determination of concentration of supplied $BaCl_2$ by standard Na_2SO_4/K_2SO_4 conductometrically.

B. Industrial and Green Chemistry Practical (40 Marks) Time: 4 hours

Industrial Chemistry Practicals: Marks: 20

1. [4+2] Cycloaddition reaction (Diels-Alder reaction between furan and maleic acid using water as solvent)
2. Base catalyzed aldol condensation (Synthesis of dibenzalpropanone).

3. Separation of reactions products by Column chromatography.

Green Chemistry Practicals: Marks:20

1. Preparation of Manganese(III) acetylacetonate by using $KMNO_4$ and acetylacetone.
2. Preparation of Iron(III) acetylacetonate by using $FeCl_3$, KOH and acetylacetone.
3. Acetylation of primary amine by using Aniline, Glacial acetic acid and Zinc dust catalyst.

RECOMMENDED BOOKS

Organic Chemistry(Honours):

1. Organic Chemistry - I.L. Finar, Vol. I, 6th Edn. ELBS
2. Advanced Organic Chemistry - J. March
3. A guide to Organic Reaction Mechanism - P. Sykes, Orient Longman.
4. Organic Chemistry - R.T. Morrison & R.N. Boyd, Prentice – Hall.
5. Fundamentals of Organic Chemistry - Solomon
6. Organic Chemistry - Wade (Jr)
7. Stereochemistry of Carbon Compounds - E. Eliel.
8. Stereochemistry of Carbon Compounds - D. Nasipuri, John Wiley
9. Organic Spectroscopy - Y.R. Sharma
10. Organic Spectroscopy - W. Kemp
11. Organic Spectroscopy - P.S. Kalshi
12. Organic Reaction Mechanism - P.S. Kalsi
13. Organic Reaction mechanism - R.K. Bansal
14. Advanced Organic Organichemistry - N.K. Visnoi
15. Advanced Practical Chemistry - R. Mukhopadhaya& P. Chatterjee.
16. Advanced Organic Chemistry – Miller
17. Organic Chemistry - Loudon

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 – Mallick, Tuli, Madan
5. Inorganic Chemistry - Sharpe
6. Inorganic Chemistry - W.W. Porterfield
7. Introductio n to Modern Inorganic Chemitry - Mackay & Mackay
8. Elements of Bioinorganic Chemistry - G.N. Nukherjee& A. Das
9. Fundamental Concepts of Inorganic Chemistry-A.K. 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 - Banwell
8. Introductory Quantum Chemistry – A.K. Chandra, TATA McGraw Hill.
9. Quantum Chemistry – D.A. Mcquarrie, Viva Books, Pvt. Ltd.
10. Atomic Structure and Chemical Bonds – ManasChandtra
12. Programming in Basic –S. Gottfired
13. Programming in Basic –Balaguruswamy.
14. Statistical Methods – N.G. Das
15.J.O'M, Bockris and A.K.N. Reddy, *Modern Electrochemistry*, Vol.1&2 (1998). Plenum Press, New York.
16.P.W. Atkins and R.S.Friedman, *Molecular Quantum Mechanics*, 3rd Ed.(1997) Oxford University Press.
17. K.J.Laidler, Chemical Kinetics, 3rd Ed.(1967), Harper and Row Publishers, New York
18.H.Eyring, S.H. Lin and S.M.Lin, *Chemical Kinetics*, (1999)Jhon Willey, New York.

Practical Chemistry(Honours):

1. Vogel's Qualitative Inorganic Analysis - G. Svehla
2. Hand Book of Organic Analysis-qualitative & quantitative-H.T. Clarke
3. Qualitative Analysis - V. Alexeyev
4. University Hand Book of Undergraduate Chemistry Experiments, University of Calcutta-G.N. Mukherjee (ed)
5. College Practical Chemistry-V.K. Ahluwalia, S. Dhingra& A. Gulati
6. Text Book of Practical Organic Chemistry-A.I. Vogel
7. Vogels Text Book of Practical Organic Chemistry

Industrial Chemistry(Honours):

1. Industrial Chemistry, B.K. Sharma