Credit-I

Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of $\Psi$ and $\Psi^2$, quantum numbers, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge.

Periodic Properties :

Atomic and ionic radii, ionization energy, electron affinity and electronegativity – definition, trends in periodic table and applications.

Credit-II

Chemical Bonding –I

Covalent Bond : Valence bond theory and its limitations, directional characteristic of covalent bond. Hybridisation and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to $\text{NH}_3$, $\text{H}_3\text{O}^+$, $\text{SF}_4$, $\text{ClF}_3$, $\text{ICl}_2$, $\text{H}_2\text{O}$.

Chemical Bonding –II

MO theory for homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

Credit-III

Ionic Solids

Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born Haber cycle, solvation energy and solubility of ionic solids, Fajan's rule. Metallic bond free electron, valence bond and band theories.

Weak Interactions - Hydrogen bonding, vander Walls forces.
Credit-I

S-Block Elements

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

P-Block Elements - I
Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13-16

Credit-II

P-Block Elements - II
Hydrides of boron diborane and higher boranes, borazine, borohydrides.

P-Block Elements - III
fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetranitride.

Credit-III

Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds. Basic properties of halogens, interhalogens compounds.
Credit-I 

Chemistry of Elements of First Transition Series
Characteristic properties of d-block elements. Properties of the elements of the first transition series and their binary compounds.

Complexes
Complexes illustrating relative stability of their oxidation states, coordination number and geometry.

Credit-II 

Chemistry of Elements of Second and Third Transition Series
General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry

Credit-III 

Coordination Compounds
Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.
CHEMISTRY: PAPER - I
INORGANIC CHEMISTRY

MAX MARKS: 50
45 Hrs(3 Credit)

Credit-I

Chemistry of Lanthanide Elements
Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds.

Credit-II

Chemistry of Actinide Elements
General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, Comparison between the later actinides and the later lanthanides

Acids and Bases
Arrhenius, Bronsted-Lowry, Lux-Flood, solvent system and Lewis concepts of acids and bases.

Credit-III

Non-aqueous Solvents
Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH$_3$ and liquid SO$_2$.

Oxidation and Reduction
Use of redox potential data-analysis of redox cycle, redox stability in water-Frost, Latimer and Pourbaix diagrams, Principles involved in the extraction of the elements.
Metal-Ligand Bonding in Transition Metal Complexes
   Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

Thermodynamic and Kinetic Aspects of Metal Complexes
   A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

Magnetic Properties of Transition Metal Complexes
   Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of \( \mu_s \) (spin only) and \( \mu \) effective values. Orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Electron Spectra of Transition Metal Complexes I
   Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series.

Electron Spectra of Transition Metal Complexes II
   Orgel-energy level diagram for d⁰ and d⁸ states, discussion of the electronic spectrum of [Ti(H₂O)₆]³⁺ complex ion
JECRC UNIVERSITY

Bsc IIIrd year
Semester-sixth CH-601
CHEMISTRY: PAPER - I
INORGANIC CHEMISTRY

MAX MARKS: 50
45Hrs(3Credit)

Credit-I

15 hrs

Hard and Soft Acids and Bases (HSAB):
Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness.
Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

Silicones and Phosphazenes:
Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

Credit-II

15 hrs

Organometallic Chemistry -I
Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti.

Credit-III

15 hrs

Organometallic Chemistry -II
A brief account of metal-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

Bioinorganic Chemistry:
Essential and trace elements in Biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{++} Nitrogen fixation.
JECRC UNIVERSITY
B.Sc. I Year
PAPER – II (CH-102)
ORGANIC CHEMISTRY

Max Marks - 50
45 Hrs.(2hrs./Week)

SEMESTER I

Credit – I

15 hrs.

Structure & Bonding:

Hybridization, bond length, bond angles and bond energy, localized & delocalised chemical bond, vander - waals interaction, resonance, hyper conjugation, aromaticity, Inductive & field effect, H-bonding.

Mechanism of Organic Reactions.


Credit – II

15 hrs.

Stereochemistry - I


Stereochemistry - II

Geometric isomersism - cis & trans-Isomerism, E & Z system of nomenclature, determination of configuration of geometrical isomers, geometrical isomerism in oximes & alicyclic compounds.

Conformational isomerism - Projection formulae (Fischer, Sawhorse, Newman & flying wedge formulae), interconversion of projection formulae, conformational analysis of ethane & n-butane, conformations of cyclohexane, axial & equatorial bonds, conformation of monosubstituted cyclohexane derivatives, difference between configuration and conformation.

Credit – III

15 hrs.

Alkanes –

Nomenclature, isomerism, methods of preparation (with special reference to wurtz reaction, Corey - house reaction. Kolbe reaction & decarboxylation of carboxylic acids), physical properties, mechanism of free radical halogenation of alkanes, reactivity & selectivity.

Cycloalkanes :
Ring strain in cyclopropane & cyclobutane, Baeyer's strain theory & its limitation theory of strainless rings with special reference to cyclopropane ring.

**JECRC UNIVERSITY**  
**B.Sc. I Year**  
**PAPER – II (CH-202)**  
**ORGANIC CHEMISTRY**  
**SMESTER - II**  

Max Marks - 50  
45 Hrs.(2hrs./Week)

**Credit – I**  
15 hrs.

**Alkenes:**  
Nomenclature, isomerism, relative stabilities, methods of preparation: dehydration of alcohols, dehydrohalogenation of alkyl halides, dehalogenation of vic-dihalides, pyrolysis of quaternary ammonium hydroxides; physical properties, chemical reactions: - Catalytic hydrogenation, addition of hydrogen halides, hydroboration - oxidation oxymercuration reduction, epoxidation, ozonolysis, hydration, hydroxylation with KMnO₄, substitution reactions at the allylic & vinylic positions, polymerization; regioselectivity in alcohol dehydration. Saytzeff & hofmann rules for elimination;

**Dienes:**  
Classification, structure of allene & butadiene, chemical reactions : electrophilic & free radical addition, polymerization, Diels - Alder reaction.

**Credit – II**  
15 hrs.

**Alkynes:**  

**Arenes & Aromaticity**  

**Credit-III**  
15 hrs.

**Alkyl & Aryl Halides - I**  
Nomenclature & classes of alkyl halides, methods of formation, chemical reaction. Mechanism of nucleophilic substitution reactions of alkyl halides, SN2 & SN1 reaction with energy profile diagrams.  
Polyhalogen compounds : Chloroform; carbon tetrachloride.

**Alkyl & Aryl Halides - II**  
Credit- I

U-V Spectra

IR-Spectra
Molecular vibration, Hooke's Law, selection rules, intensity on deposition of IR bands, measurement of IR spectrum, finger print region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds.

Credit – II

Alcohol
Classification and nomenclature
Dihydric alcohol - nomenclature, method of formation, chemical reaction of vicinal glycols, oxidative cleavage [Pb(OAC)₄ and HIO₄] and pinacol - pinacolone rearrangement.
Trihydric alcohols - nomenclature and methods of formation, chemical reaction of glycerol.

Phenols
Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character. Comparative acidic strength of alcohols and phenols resonance stabilization of phenoxide ion, reaction of phenols, electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, claisen rearrangement, Gatterman synthesis, Hauben - Hoesch reaction, Lederer manasse reaction & Reimer Tiemann reaction.

Credit – III

Ethers and Epoxides (cold)
Nomenclature of ether and methods of their formation, physical properties. Chemical reaction, cleavage and autoxidation, Ziesels methods synthesis of epoxides. Acid and base catalysed ring opening of epoxides, orientation of epoxide ring opening, reaction of Grignard and organolithium reagents with epoxides.

Aldehyde and Ketone - I
Nomenclature and structure of the carbonyl group, Synthesis of aldehyde and Ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketone using 1,3 dithianes, synthesis of ketones from nitrites and from carboxylic acids, physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenengel condensation.
JECRC UNIVERSITY
B.Sc. II Year
PAPER – II (CH-402)
ORGANIC CHEMISTRY

SEMESTER - IV

Max Marks - 50
45 Hrs.(2hrs./Week)

Credit – I

Aldehyde and Ketone - II

Organic Synthesis via Enolates

Credit-II

Carboxylic Acid

Carboxylic Acid Derivatives
Structure and nomenclature of acid chloride, ester, amides (Urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, inter-conversion of acid derivatives by nucleophilic acyl substitution. Preparation of Carboxylic acid derivatives, Chemical reaction, Mechanism of esterification and hydrolysis (Acidic and Basic).

Credit-III

Organic Compound of Nitrogen - I

Organic Compounds of Nitrogen - II
Spectroscopy-I
Nuclear magnetic resonance (NMR) spectroscopy, Proton magnetic resonance (H\textsuperscript{1} NMR) spectroscopy. Nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, area of signals. Interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.

Structure elucidation
Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopy techniques.

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

Organosulphur Compounds: Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonlic acids, sulphonamides and sulphaguanidine.

Amino acids, Peptides, Proteins and Nucleic acids
Nucleic acid: Introduction, Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.
JECRC UNIVERSITY
B. Sc. III year
Paper-II (CH-602)
Organic Chemistry

Semester-VI

Max. Marks – 50
45 Hrs (2 Hrs/ week)

Credit –I

Heterocyclic Compounds

Credit -II

Carbohydrates

Credit -III

Fats, Oils and Detergents
Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates.

Synthetic Dyes
Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of methyl Orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo.

Synthetic Polymers
JECRC UNIVERSITY
Chemistry Syllabus
B.Sc. 1yr. CH-103
Paper:III : Physical Chemistry

Semester I

45hrs (Two hrs per week)
max.marks:50

Credit – I 15hrs.

Mathematical Concepts : Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of function like kx, ex, xn, sin x and log x; maxima and Minima, partial differential and reciprocity relations, integration of some useful/relevant functions; permutations and combinations, Factorials, Probability.

Solid State
Definition of space lattice, unit cell.

Credit – II 15hrs.

Computers : General introduction to computers, different computer of a computer, hardware and software, input-output devices; binary numbers and arithmatic, introduction to computer languages. Programming, operating systems.

Gaseous States
Postulates of kinetic theory of gases, deviation from ideal behaviour, Vander Waals equation of state. Critical Phenomena : PV isotherms of real gases; continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Vander Waals constants, the law of corresponding states, reduced equation of state.

Credit – III 15hrs.

Diffraction
X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl, and CsCl (Laue's method and powder method).

Velocities
Molecular velocities, Root means square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, means free path and collision diameter. Liquification of gases (based on Jould-Thomson effect).
JECRC UNIVERSITY
Chemistry Syllabus
B.Sc. I yr. CH-203
Paper: III : Physical Chemistry
Semester II

45hrs (Two hrs per week)
max.marks: 50

Credit- I

Liquid State
Intermolecular forces, structure of liquids (a qualitative description).
Structural differences between solids, liquids and gases.
Liquid crystals: Difference between liquid crystal, solid and liquid.
Classification, Structure of nematic and cholesteric phases.

Colloidal State
Definition of colloids, classification of colloids. Solids in liquids (sols): Properties - kinetic, optical and electrical;
stability of colloids, protective action. Hardy-Schulze law, Glod number. Liquid in liquids (emulsions), types and
preparation of emulsions, emulsifier. Liquids in solids (gels): Classification, preparation and properties, inhibition,
general application of colloids.

Credit - II

Chemical Kinetics I
Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction Concentration
dependence of rates, mathematical characteristics of simple chemical reactions – zero order, first order, second
order pseudo order, half life and means life. Determination of the order of reaction – differential method, method
of integration, method of half life period and isolation method.
Radioactive decay as a first order phenomenon. Experimental methods of chemical kinetics: conductometric,
potentiometric, optical methods, polarimetry and spectrophotometry. Theories of chemical kinetics: effect of
temperature on rate of reaction, Arrhenius equation, concept of activation energy.

Credit- III

Chemical Kinetics II
Simple collision theory based on hard sphere model transition state theory (equilibrium hypothesis). Expression
for the rate constant based on equilibrium constant and thermodynamic aspects.

Catalyst
Characteristics of catalysed reactions, classification of catalysis, miscellaneous examples, mechanism of catalyzed
reaction, mechanism by steady state treatment, acid base catalysis, kinetics of specific and general acid base
catalysis, enzyme catalysis, determination of Michaelis constant, mechanism and kinetics of surface catalyst.
JECRC UNIVERSITY

B.Sc. IIyr. CH-303
Paper—III, Physical Chemistry
Semester III

45hrs (2hrs per week)
max.marks:50

Credit-I 15hrs.

Thermodynamics-I

Credit-II 15hrs.

Thermochemistry

Thermodynamics-II
Second Law of Thermodynamics: Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium, Entropy change in ideal gases and mixing of gases.

Credit-III 15hrs.

Thermodynamics-III
Third law of thermodynamics: Nernest heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions: Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as Criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T.

Chemical Equilibrium
Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle. Reaction isotherm and reaction isochore-Clapeyron equation and Clausius. Clapeyron equation, applications.
Phase Equilibrium
Statement and meaning of the terms - phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system- water, CO\textsubscript{2} and S systems phase equilibria of two component system - solid - liquid equilibria, simple eutectic Bi - Cd, Pb-Ag systems, desilverisation of lead. solid solution - compound formation with congruent melting point (Mg-Zn) and incongruent melting point (NaCl-H\textsubscript{2}O), (FeCl\textsubscript{3} - H\textsubscript{2}O) and CuSO\textsubscript{4}-H\textsubscript{2}O system, Freezing mixtures, acetone-dry ice.

Liquid-liquid mixtures
Ideal liquid mixtures, Raoult's and Henry's law, Non-ideal system-azeotropes - HCl-H\textsubscript{2}O and ethanol water systems.Partially miscible liquids - Phenol- water, trimethylamine -water nicotine water systems, Lower and upper consolute temperature, Effect of impurity on consolute temperature. Immiscible liquids steam distillation. Nernst distribution law-thermodynamic derivatio, applications

Credit-I 15hrs.

Electrochemistry-I
Electrical transport - conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes. Ostwald's dilution law. Debye-Juckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements : Determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titerations.

Credit-II 15hrs.

Electrochemistry-II
Types of reversible electrodes - gas - metal ion, metal -metal ion, metal-insoluble salt-anion and redox electrodes, Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode-standard electrode potential, sign conventions, electrochemical series and its significance. EMF of a cell and its measurements, computation of cell EMF. Calculation of thermodynamic quantities of cell reactions (\textit{\Delta G} \textit{\Delta H} and \textit{K}), polarization, over potential and hydrogen overvoltage. concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titerations, determination of pH using hydrogen quinhydrone and glass electrodes, Buffers - mechanism of buffer action, Henderson-Hazel equation, Hydrolysis of salts.
JECRC UNIVERSITY
Chemistry Syllabus
B.Sc. III yr. CH-503
Paper:III : Physical Chemistry

Semester V

45hrs (Two hrs per week)
max.marks:50

Credit-I

Elementray quantum Mechanics
Black-body, radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects. Compton effect. De Broglie hypothesis. Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box.

Credit-II

Molecular orbital theory and Hybridization
Basic ideas-criteria for forming M.O. from A.O. construction of M.O's by LCAO. calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of sigma –sigma-star, Pi-Pi star orbitals and their characteristics. Hybrid orbitals - sp, sp2, sp3, calculation of coefficients of A. O's used in these hybrid orbitals. Introduction to valence bond model of hydrogen molecule, comparison of M.O. and V.B. models.

Photochemistry
Introduction, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Drapper law, Stark -Einstein law, Jablosnski diagram depicting various processes occuring in the exited sate, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions.

Credit-III

Surface Chemistry
General terms used in adsorption, factors affecting adsorption, monomolecular and multi molecular layer adsorption, Freundlich and Langmuir adsorption isotherm, BET theory and equation (no derivation), Gibbs adsorption isotherm.

Electronic Spectrum
Concept of Potential Energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Frank Condon principle. Qualitative description of sigma, Pi, and n M.O. their energy levels and the respective transitions.
Credit-I

Spectroscopy I - Rotational Spectrum

Spectroscopy II - Vibrational Spectrum
Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Credit-II

Spectroscopy III - Raman Spectrum
Concept of polarizability, pure rotational and pure vibrational Raman Spectra of diatomic molecules, selection rules.

Physical Properties and Molecular Structure
Optical activity, polarization - (Calusius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties paramagnetism, diamagnetism and ferromagnetics.

Credit-III

Solutions, Dilute Solutions and Colligative Properties