Dept. of Chemistry

B.Sc I^st year

Inorganic Chemistry (Code: B-106)

Unit	Module	Specific Outcomes
1	**AtomicStructure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principal.atomic orbitals, Schrodinger wave equation, quantumnumbers,radialandangularwavefunctions analprobability distributioncurves, shapes ofs, p, d, orbitals,AufbauandPauliexclusionprinciples,Hund's multiplicityrule.electronicconfigurationsoftheelements,effectivenuclearcharge. **PeriodicProperties:** Atomicandionicradii, ionizationenergy,electronaffinity.electronegativity-definition, methods of determinationor evaluation.trends in periodic table and applications in predicting and explainingthechemicalbehavior.	After studying this lesson students will be able to: • .Understand the basic concept of atomic structure. • Able to learn about quantum numbers, different laws for writing the electronic configuration of the elements • Recap the characteristics of elements in the Periodic Table. Includingatomic radius, Ionisation energy, electronaffinity. Electronegativity. their general trends in periodic table across a period and group. The exceptions to the general trends across a period and group
2	**ChemicalBonding-** CovalentBond — Valencebondtheoryanditslimitation.directionalcharacteristicofcovalentbond,varioustypesofhybridization and shaped of simple inorganic rnolcculcsandions,valenceshallelevtronpairrepulsion(VSEPR)theoryto NH_3,H_3O^+,SF_4,CIF_3,ICl_2andH_2O,MOtheory,homonclearandheteronuelear(COandNO)diatomicmolecules, multicenter bondingin electron deficientmolecules.bondstrengthand bondenergy.percentageionic characterfromdipolemomentandelectro-negativedifference. **IonicSolids**— Ionicstructures,radiumratioeffectandcoordinationnumber,limitation of radius ratio rule, latticedefects, semiconductors, lattice energy and BonnHaber cyclc.salvationenergyandsolubilityofionicsolids,polarizing powerandpolarisalityofions,Fajan'srule,MetallicbondFreeelectron,valencebondandband theories **Weak interactions**—Hydrogen bonding, VanderWaalsforces.	After studying this lesson students will be able to: • explain covalent bonding in terms of the sharing of pairs of electrons (Single, double and triple covalent bonds) represent covalent bonds in molecules using dot and cross diagrams distinguish between sigma and pi bonding distinguish between polar and non-polar covalent bonding • Describe the shapes of simple molecules using the basis for electron pair repulsion theory • Be able to explain the principals and mechanisms that govern ionic crystal structure formation • Define week interactions among different molecule.

3	**s-BlockElements:** Comparativestudy,diagonalrelationship, salientfeaturesofhydrides,salvationandco mplicationtendenciesincludingtheirfunctio ninbiosystems,andintroductiontoalkylsand aryls. **ChemistryofNobleGasses:** Chemicalpropertiesof thenoblegases,chemistryof xenon,structureandbondinginxenonc ompounds	After studying this lesson students will be able to: Recall methods for the synthesis of the s & p block elements. Recall the structures, the properties, applications, and the chemical reactivity of the s & p block elements.
4	Comparative study, including diagonal relationship of groups 13-17elements, compounds like hydrides, oxides oxyacids and halides ofgroupI 3-1 6,hydridesofboroii-diboraneandhigherboranes,borazine,borohydrides,tiille renes,carbides,fluorocarboñs, silicates(slrl)CRiTJincipal), tetrasulphur tetra nitride, basic properties ofhalogens,interhalogensandpolyhalides	

B-Sc. I Year

Organic Chemistry code:(B-107)

Unit	Module	Specific Outcomes
1	**StructureandBonding** hybridization, bond lengths and bond angles,bond energy,localizedand delocalizedchemical bonding, van der Wallsinteractions.inclusioncompounds,clatherates,Chargetransfercomplexes.resonances,hyperconjugation,aromaticity,inductiveeffect,hydrogenbonding. **MechanismofOrganicReactions:** Curved arrow notation,Drawing electronmovements with allow.half-headed and double-headedarrows, hemolytic and hetcrolysisbondfission,typesofreagents-electrophilesandnucleophiles,Typesoforganicreaction,Energyconsideration. Reactiveintermedates—Carbocations,carbanions,Seeradicals.carbenes,arynesandniters(withexamples)/Assigningform:ilcharges on intermediates, isotope effects, kinetic and stereochemicalstudies). IUPACnomenclatureof branchedandunbranchedandunbranchedalkanes,the alkyl group, classification of carbonatomin alkancs.Isomerismin alkanes, sources methods of formation (withspecialreference to Wurtz reaction, Kolbe reaction, Corey-House reactionanddecarboxylation of earboxylicacids),physicalpropertiesandchemicalreactionsofalkanes,Mechanismoffreeradicalhalogenationsofalkanesorientation,reactivityandselectivity. **Alkanes and Cycloalkanes**-Nomenclature. methodsofformation,chemicalreactions, Baeyei's strain theory and its limitations. Ring Straininsmallrings (cyclopropaneandcyclobutane),theory of strainlessrings.Thecaseocyclopropanering,bananabonds.	After studying this lesson students will be able to: • Identify, classify,organize, analyze and draw structure of organic molecule • Provide correct IUPAC names for alkanes, halocarbons, alkenes, and aromatics, including cyclic molecules and including stereochemistry • Predict and explain patterns in shape, structure, bonding, hybridization, formal charge, stability, acidity, basicity, solubility, and reactivity for hydrocarbons, halocarbons, alkenes, dienes, and arenes, by understanding and applying concepts of organic chemical structure and bonding and stability. • Predict and explain patterns in stability, shape, hybridization, reactivity, and product formation when resonance or conjugation applies to a reactant, intermediate, or final product

2	**Stereochemistry of Organic Compounds** Conceptofisomerism,typesofisomerism; Opticalisomerism-elementsofsymmetry,molecularchirality,enantiomers,stereogeniccenter,opticalactivity,propertiesofenantiomerschiml and achiral moleculeswith two sterogeniccenters,diastereomers, meso compounds,resolutionof enantioraner,inversion,retentionandrecemization. Ssystemsofnomenclature. Geometricisomerism-determination of configurationof geometricisomers, E & Z system of nomenclature, geometric isomerisminoximesandalicycliccompounds. Conformational isomerism-conformational analysis of ethane and n-butane ;confomiations of cyclohexane, axial and equatorial bonds,conformation of mono substituted cyclohexane derivatives, Newmanprojectionand Sawhorse fomiulae, Fischer and flying wedgeformulae,Differencebetweenconfigurationandconformation	After studying this lesson students will be able to: • Classify molecules as chiral or achiral, identify chiral carbons as (R) or (S), identify relationships between pairs of molecules as enantiomers, diastereomers, or equivalent, and identify when a solution is racemic versus optically active.
3	Alkenes,Cyeloalkenes,DienesandAlkynes: Nomenclature of alkenes, methods of formation, mechanisms ofdehydrationof alcohols and dehydrohalogenation of alkylhalids,regioslectivity in alcohol dehydration, The Saytzeff rule, Hofmannelimination,physicalpropertiesandrelativestabilitiesofallenes. Chemicalreactionsofalkenes-mechanisminvolvedinhydrogenation,electrophilicandfreeradicaladditions,Markownikoff'srule,hydroboration-oxidation,oxymercuration-reducation. Epoxidation, ozonolysis, hydration, hydroxylation andoxidation withnOd, POlymerizatiOn of alkenes, Substitution atthe allylic and vinylic positions of alkenes, industrial applications ofethyleneandpropane.Methodsofformation,conformationaridchemicalreactionsoicycloakenes; Nomenclature and classification of dienes :isolated, conjugatccl andcumulateddienes,strictureof allenes andbutadiene,methodso1'formation, polymerization, chemical reaction-1, 2and 1, 4 additi‹ins.Diels-Alderreaction,Nomenclature,structureandbondingillalkynes,methodsofformation,chemicalreactionsof.alkynes.acidityofalkynes,mechanismofelectrophilicandn iclephilicadditionreactions,hydroboration-oxidation,metal-ammonia reductions,oxidationaridpolymerization.	After studying this lesson students will be able to: • predict physical properties, nomenclature, synthesis, reactions, mechanisms, and synthesis of alkenes, dienes, alkynes • Be able to recognize, classify, explain, and apply fundamental organic reactions such as SN2, SN1, E2, E1, alkene addition, electrophilic aromatic substitution, 1,2/1,4-additions, ring-opening, and radical halogenation. Be able to apply concepts associated with these general reaction types to product prediction, synthesis design, and reaction mechanism.

4	**ArenesandAromaticity:**Nomenclatureofbenzenederivatives,the arylgroup,Ai'‹›iua1icnucleus and side chain, structure of benzene; molecular iorintil8 analkekulestructure,stabilityandcarbon-carbonbondlengthsof'benzene,resonance structure,MOpicture. Armaticity:TheHucklerule.aromatic:ions. Aromatic electrophilicsubstitution -general pattern of themechanism,roleofsandpcomplexes,Mechanismofnitration.halogenations, sulphonation,mercuration andFriedel-Craft reaction,Energyprofile diagrams, activating anddeaelivatin‹substituent'sorientationandortho/pararatio,sidechainreactionsoi'benzenederivatives,birchreducation. Methodsofformation andchemical reactionsofalkybenxciics,alkynylbenzenes andbiphenyl,naphthaleneandAnthraeenc. AlkylandArylHalides:Nomenclatureand classes of alkylhalides, methods of formation.chemicalreactions,mechanismsofnucleophiliesiibsititiiti‹›iireactions of alkyl halides, Ss2 and SNreactions with energyprofiiediagrams;Polyhalogen compounds:Choloroform,carbon tetraehloridc; Methods offormationofarylhalides, nuclearand sidechain reactions;Theaddition-eliminationandtheelimination-additionmechanismsofnuclcophilcaromaticsubstitutionreactions;Relativereactivatesofalkylhalidcsvsallyl,vinglandarylhalides,synthesisandusesofDDTandBHC.	After studying this lesson students will be able to: • Interpret the concept of aromaticity and the main properties of aromatic compounds • predict physical properties, nomenclature, synthesis, reactions, mechanisms, and synthesis of Benzene, alkyl and aryl halides

B.Sc. I

Physical Chemistry Code : (B-108)

Unit	Module	Specific Outcomes
1	**MathematicalConceptsandComputers**:MathematicalConcepts:Logarithmicrelations,curvesketching,lineargraphsanticalculationof slopes, differentiationof functionsK,.e^x, X^nsinx,log x;maximaandminima,partialdifferentiationandreciprocityrelations,Intergrationofsomeuseful/relevantfuctions;permutationsandcombinationsFactorials. Computers :General introduction to computers, different components ofcomputer, hardware and software, input-output devices; biliarynumbers and arithmethic's introduction to computer languages,pmgrammingoperatingsystems.	After studying this lesson students will be able to: • Understand and apply the basic mathematics involve in Physical Chemistry • Gain a basic understanding of computer hardware and software and will develop problem-solving skills. • Apply logical skills to programming in a variety of languages.
2	**Gaseous States-** Postulates of kinetic theoryofgases, deviation from idealbehavior.Vander Walls equation of state. Critical Phenomena : PV isotherms of real gases, continuity of states. the isotherms of vanderWaals equation, relationship between critical constants and vander Waals constants, the law of corresponding states, reduced equation of state.Molecular velocities : Root mean square, average, and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. liquefaction of gases (based on joule-Thomson effect). **LiquidState**:Intermolecular forces, structure of liquids (a qualitative description)Structuraldifferencesbetweensolids,liquidsandgases; Liquid crystals:Difference between liquid, crystal, solid andliquid,Classification, structure of nematicand cholestricphases,Thermographandsevensegmentcells.	After studying this lesson students will be able to: • Understand the physical characteristics shared by gases and liquids • Understand about different theories, relationships involve in gaseous and liquid states.
3	**SolidStates**: Definitionofspacelattice,unitcell;Laws of crystallography-(i} Law of constancy of interfacial angles, (ii)law of rationality of indices (iii) Law of symmetry, symmetry elements incrystals. X-ray diffraction by crystals, Derivation of Bragg equation, Determinationof crystal stricture ofNaCL, KCI and CsCI (Laue's method and powdermethod). **ColloidalStates:** Definitionofcolloids,classification ofcolloids; Solids liquids (sols): properties-kinetic, optical and electrical; stability ofcolloids,protectiveaction,Hardy-	After studying this lesson students will be able to: • Understand the physical characteristics shared by all solids and colloids • Understand about different theories, relationships involve in solids and colloids. • Understand the kinetics of different reactions, factors influencing the rate of reaction different theories and relations involve in kinetics of reactions

	Schulzelaw,goldnumber.Liquids inliquids (gesl):classification, preparation and properties,inhibition,generalapplicationofcolloids,colloidalelectrolytes **ChemicalKinetics:** Chemical Kinetics and its scope, rate of a reaction, factors influencing therateofareaction-concentration,temperature,pressure,solvent,lightcatalyst, concentrationdependenceofrates,mathematicalcharacteristicsof simlechemicalreactions-zero order,first order,secondorder,pseudoorder.halflifeandmeanlife,determinationoftheorderofreaction-differential methods,methodofintegration,methodofhalflifeperiodandisolation method. Radioactivedecayasafirstorderphenomenon; Experimentalmethodsofchemical Kinetics:conductometric, potentiometric,optical methods,polarimetiyandspectrophotometric.Theoriesofchemical kinetics:effectoftemperatureonrate of reaction.Arrheniusequation,conceptofactivationenergy.Simple collision theory based on hard.spheremodel, transition slate theory;(equilibriumhypothesis),Expressionfortherateconstantbasedonequilibriumconstantandthermodynamicaspects.Catalysis,characteristicsof catalysedreactions,classificationof catalystshomogeneousandheterogeneouscatalysis,enzymeanalysis.miscellaneousexamples.	

(B.Sc. I) Code: (P-406)

Practical ~~Code: (P-406) (X)~~

This laboratory course enables students to determine various physicochemical properties of some chemicals, solutions, mixture etc. for example they will be able to determine the water of crystallization, viscosity of liquids, distribution coefficient of a compound in different solvent.

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After completion of this course students will be able to analyze the organic sample quantitatively. This will help students to work in some laboratory and find the percentage of a metal atom in a solution. They will be able to find the hardness of water from any natural source.

This course teach student to separate the inorganic ions from a mixture and analyze them quantitatively.

the students will be able to understand different types of surface processes like visocity, surface tension

M.M. COLLEGE MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: INORGANIC CHEMISTRY
CLASS: B.Sc.II, Ist PAPER
PAPER CODE: B-206
MAX.MARKS : 100

Course Description:

This course is an introduction to inorganic chemistry.

Topics include Chemistry of Elements of first Transition Series, Chemistry of Element of second and third Transition Series, Coordination Compounds, Chemistry of Lanthanide and Actinide Element, Oxidation and Reduction, Acid and Bases and Non Aqueous Solvents.

Course Objectives:

- Advanced Inorganic Chemistry", R.D.Madan
- "Inorganic Chemistry", P.L. Soni
- To explain the characteristics properties of d-block elements, binary compounds hydrides, carbides and oxide of first Transition Series with relative stability, oxidation state, coordination state, coordination number and geometry.
- To explain the general characteristics of second and third Transition Series with respect to ionic radii, oxidation state, megnetic behaviour,spectral properties and stereochemistry.
- To explain coordination compounds, Warner's Coordination theory and it's experimental verification, effective atomic number, chelates and nomenclature of coordination compounds, isomerism in coordination compounds.
- To explain the Chemistry of Lanthanide and Actinide Element with electronic structure, oxidation state, ionic radii and megnetic properties, Lanthanide and Actinide contraction and chemistry of separation of Nu,Pu and Am from U.

 To explain why specific reducing agents are used for the reduction purposes.

 To understand the principles of oxidation and reduction as applied to the extraction procedure.

 To explain the various acids and bases theory.

 To explain physical properties of a solvent, types of solvent and their general characteristics, reaction in non aqueous with reference to liquid NH_3 and liquid SO_2.

Course Outcome (COs):

Upon successful completion students should be able to:

 The above two books are prescribed texts for B.Sc.II, INORGANIC CHEMISTRY,

•CO1. The fundamentals of the chemistry of the d-block elements with their characteristics properties.

•CO2.Basic knowledge of first, second and third Transition Series with their characteristics properties.

•CO3. To Understand the chemistry of Lanthanide and Actinide Element with their characteristics properties and separation chemistry and both Lanthanide and Actinide contraction.

•CO4.To understand the principles of oxidation and reduction as applied to the extraction procedure.

•CO5.To understand the various acids and bases theory.

•CO6.To understand the nature of non aqueous solvent like liquid NH_3 and liquid SO_2.

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M.M. COLLEGE MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: ORGANIC CHEMISTRY
CLASS: B.Sc.II, PAPER II
PAPER CODE: B-207
MAX.MARKS: 100

Course Description:

Students review the basic principles of chemical bonding as they apply to organic molecules and are introduced to the concepts of functional groups, nomenclature, stereochemistry, and reaction mechanisms. The systematic chemistry of alcohols, Phenols,Ethers and Epoxide, Aldehyde and Ketones, carboxylic acid and their derivatives and organic compounds of Nitrogen. amines and benzen diazonium chloride are discussed.

Course Objectives:

- "Organic Chemistry", P.L.Soni
- "Advanced Organic Chemistry", B.S.Bahl and Arun Bahl.
- To learn about electromagnetic spectrum and absorption spectra (UV and IR).
- To learn about various methods of preparation and applications of Alcohols and Phenols. Oxidative cleavage, chemical reaction of glycerol, mechanism of famous name reaction and rearrangement reactions.
- To estimate no of hydroxyl groups and alkoxy group in alcohol and ether.
- To understand the term rectified spirit and methylated spirit.
- To explain the mechanism of few selected reactions of aldehyde and ketones.
- To describe the methods of preparation and reactions of acids.
- To know about the oxidising and reducing reagents and their nature.
- To understand the difference between primary, secondary and tertiary Alcohol and same to Amines.

Course Outcome (COs):

Students will gain an understanding of:

a.The use of ultraviolet and infrared spectroscopy for organic structure elucidation

b. The fundamentals of electronic structure and bonding in conjugated and aromatic systems.

c. Reactivity patterns of conjugated and aromatic molecules

d. The fundamental electronic structure and bonding in carbonyl compounds.

e. substituent effects on pKa (in the case of carboxylic acids)

f. The reactivity of carbonyl compounds with both hard and soft nucleophiles (carboxylic acids, aldehydes and ketones)

g. The kinetics and thermodynamics of carbonyl condensation reactions

h. The fundamental properties and reactivity of biologically important molecules(amines).

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M.M. COLLEGE MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: PHYSICAL CHEMISTRY
CLASS: B.Sc II,PAPER III
PAPER CODE: B-208
MAX.MARKS: 100

Course Description:

This course is aimed to provide the students with a solid understanding of all the fundamental concepts physical chemistry necessary for the study of the more advanced or specialized courses that follow. The topics discussed include Thermodynamics and Electrochemistry.

Course Objectives:

- To understand laws of thermodynamics.
- To discuss the Phase equilibrium.

Course Outcome (COs):

Students will gain an understanding of:

- The application of mathematical tools to calculate thermodynamics.
- the relationship between microscopic properties of molecules with macroscopic thermodynamic observables
- the derivation of rate equations from mechanistic data
- the use of simple models for predictive understanding of physical phenomena associated to chemical thermodynamics and kinetics
- the limitations and uses of models for the solution of applied problems involving chemical thermodynamic and kinetics.
- Students learn depth concepts about electrochemistry.
- Students learn solutions and phase equilibrium.

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M.M. COLLEGE MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: CHEMISTRY PRACTICAL
CLASS: B.Sc.II
PAPER CODE: P-506
MAX.MARKS : 50

Organic Analysis, Volumetric Analysis and measurement of transition temperature.

Course Description:

This course aims to familiarize students with the principles of analytical chemistry and basic analytical techniques including volumetric analysis. This course is not open to Chemistry or Analytical and Testing Sciences major students.

Course Objectives:

- Experimental practice of quantitative volumetric analysis.
- The objective of the titration is the determination of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.
- The main objective of volumetric analysis is to determine the amount of a substance in a given sample. When dealing with volumetric analysis the concept of concentration cannot be avoided. Molarity i.e. moles per litre or decimeter is widely used unit of concentration.

Course Outcome (COs):

Upon successful completion students should be able to:

- Analysis of given organic mixture i.e. elemental analysis, functional groups analysis and measurement of boiling and melting point.
- measurement of transition temperature of given compound.
- Facilitate the learner to make solutions of various molar concentrations.

This may include: The concept of the mole, Converting moles to grams, Converting grams to moles, Defining concentration, Dilution of Solutions, Making different molar Concentration.

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COURSE – INORGANIC CHEMISTRY

PAPER - I CODE – B-306

B.Sc- III Year

After studying this course, student should be able to

1. Understand the chemistry of transition metals in detail including properties and their uses.
2. Describe the metal legend bonding and magnetic behavior of transition metals in deferent conditions.
3. Identify and explain the electronic spectra of many transition metals complexes.
4. Explain the thermodynamics and kinetic aspects of transition metals complexes in deferent ways.
5. Understand the organ metallic and bio organic chemistry.

COURSE – ORGANIC CHEMISTRY

PAPER - II **CODE – B-307**

B.Sc- III Year

After studying this course, student should be able to

1. Understand the concept of different spectroscopy like UV, IR and NMR etc.
2. Explain the chemistry of not only organometallic compounds but also heterocyclic compounds.
3. Describe the physiological effect and detail study of many bio macro molecules i.e. Carbohydrates, amino acid and proteins.
4. Explain the structure of nucleic acid RNA & DNA and their importance to understand the concept of genes.
5. Understand the preparation, properties and application of fats, oil, soaps, and detergents. Student can think the use of these in many industries.
6. Explain the chemistry of synthetic polymer and dyes and their uses in synthesis of many compounds.

COURSE – PHYSICAL CHEMISTRY

PAPER - III CODE – B-308

B.Sc- III Year

After studying this course, student should be able to

1. Explain the quantum mechanism and elementary idea of spectroscopy.
2. Understand the molecular structure and physical properties of compounds with the help of advance technique of spectroscopy.
3. Explain theory and interaction of excited states in photo chemistry. Application of photo catalysis to explain the environment impact of atmosphere photo chemistry.
4. Describe the molecular structure of compound and can understand electronic, UV, rotational (Microwave), vibrational (IR) and Raman spectra.
5. Understand the quantum mechanism, Compton Effect, hydrogen spectra and function of Hamiltonian operator.
6. Explain VBT, MOT and wave function which are the important topics for competition examinations.

COURSE – ANALYTICAL CHEMISTRY

PAPER - **CODE – P-606** (Practical)

B.Sc. - III Year

After studying and practice of practical in this course, student should be able to

1. Describe not only the separation of binary mixture but also the identification of compounds present in the mixture.
2. Understand nitration, benzoylation, diazotisation and acetylation mechanism by preparation of organic compounds.
3. Explain concept of conductance.

M.M. COLLEGE, MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: INORGANIC CHEMISTRY – I
CLASS: M.Sc.SEMESTER -I
PAPER CODE: H-1007 External = 50
MAX. MARKS : 100 Internal = 50 (2×15 + 2×5 + 10 = 50)

Course Description:

This course is an introduction to modern inorganic chemistry. Topics include stereochemistry and bonding in main group compound and metal ligand equilibria in solutions, including reaction mechanism of transition metal complexes and redox reaction(election transfer reaction) and metal ligand bonding.

Course Objectives:

1. Advanced Inorganic Chemistry", R.D.Madan G.D.Tuli, Sat Prakesh.
2."Inorganic Chemistry", P.L. Soni
3. Advanced Inorganic Chemistry, F.Jolly
4. To explain the formation of different types of bonding.
5.To explain the concepts of geometry of simple molecules.
6.To explain the term VSEPR theory, Walsh's Diagram, and Bent rule.
7.To explain stepwise and overall formation constant and their interactions. Factor affecting the stability of metal complexes, chelates effects and their thermodynamics origin.
8.To explain energy profile of the reaction and reactivity of metal complexes, kinetics of Substitution reaction acid hydrolysis, Trans effect and mechanism of Substitution reaction in square planer complexes.
9.To explain adjusted CFT and limitations of CFT, application in tetrahedral, octahedral and square planer complexes.

Course Outcome (COs):

Upon successful completion students should be able to:

The above three books are prescribed texts for first semester.

•CO1 Predicting geometries of simple molecules.

•CO2 Basic knowledge of metal complexes, Chelates effects, stepwise and overall formation constant and their intraction, factors affecting stability of metal complexes, kinetics of Substitution reaction, Substitution reaction mechanism in square planer complexes,Trans effect.

•CO3 CFT limitations and Adjusted CFT it's application in tetrahedral octahedral and square planer complexes.

•CO4. Discuss the d-orbital splitting pattern in different geometries like octahedral, tetrahedral.

• CO5 Calculate magnetic moment & crystal field stabilization energy of metal complexes.

• CO6 Explain high spin and low spin complexes & formation of metal complexes in solution.

• CO7 Determine stability constant of particular complex through pH metry.

• CO8 Explain different types of substitution reaction like SN1,SN2 etc ,and difference between acid hydrolysis & base hydrolysis.

• CO9 Discuss how ligand substitution reaction takes place in octahedral and square- planar, trans

effect and trans influence and how trans effect is applicable in synthesis of different metal complexes.

• CO10 Explain about different types of electron transfer reaction (one electron transfer reaction and (direct electron transfer reaction) factors affecting them.

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Chemistry M.Sc. I Semester

Organic chemistry – I

Code: (H-1008)

The course is an introduction to Advance organic chemistry. The different topics in the course are Chemical bonding, stereochemistry, Reaction mechanism with reference to structure and reactivity, Aliphatic Nucleophilic substitution and Aliphatic ~~Nucleophilic~~ Electrophilic Substitution Reactions.

Course outcomes:

After studying these topics the students will be able to understand the nature of chemical bonding and stereochemistry of different organic compounds. They will also ~~Know~~ about the reaction mechanism of different organic compounds and they also will be able to predict the nature of the compounds by looking into their structures only.

M. Sc. I Semester

Physical Chemistry-I

Unit-1 Code : (H-1009)

I Quantum mechanics

1. Introduction to Exact Quantum Mechanical Results

Schrödinger wave equation and thepostulates of quantum mechanics. Discussion of solutions of Schrödinger equation to some model system viz. particle in a one-dimensional box ,harmonic oscillator the rigid rotator, the hydrogen atom.

effect*.

2. **Approximate methods:**

The variation Theorem, linear variation principal, Perturbationtheory (first order and nondegenerate) Application of variation method and perturbation theory to the Helium atom.

3. **Angular momentum**
   Ordinary angular momentum, generalized angular momentum, Eigen functions and eigen values of angular momentum, operators using Ladder operator, addition of angular momenta, spin, anti symmetry and Pauli's exclusion principle,

4. **Electronic Structure of Atoms**
   Electronic configuration, . Russell-Saunders terms and couplingschemes, Slater-Condon parameters, term separation energies of the pn configuration, term separation energies for dn configuration, magnetic effects: spin orbit coupling and Zeeman splitting, introduction to the methods of self consistent field, the virial theorem.
5. **Molecular Orbital Theory**
   Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory

II Thermodynamics

1. **Classical Thermodynamics**
   Brief resume of concepts of laws of thermodynamics – free energy, chemical potential and entropies. Partial molar properties – partial molar free energy, partial molar volume, partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and its determination
2. **Statistical Thermodynamics**
   Concepts of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging, Canonical, grand canonical and micro canonical ensembles, corresponding distribution laws (using lagrange's method of undetermined multipliers)

Partition functions – translational, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.
heat capacity behaviour of solids – chemical equilibria and equilibrium constant in term of partition functions, Fermi-Dirac statistics, distribution law and applications to metal. Bose-Einstein statistics – distribution law and application to helium.

3. Non Equilibrium Thermodynamics
Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow. Entropy balance equation for different irreversible processes (e.g., heat flow, chemical reaction etc.). Transformations of the generalized fluxes and forces, non equilibrium stationary states, phenomenological equations, Gibb's equation, microscopic reversibility.

Learning Outcomes

This physical chemistry course intends to enlighten the students on topics like classical and statistical thermodynamics and electrochemistry. This course induces to understand the energy concerns.
In this course students will be able to

- Acquire a deeper knowledge about physical chemistry.
- Use mathematical techniques in linear algebra for eigenvalues and eigenvectors and first and second order differential equations not only in quantum chemistry but in other areas of physical and theoretical chemistry
- Solve all the model problems in quantum mechanics for which exact analytical methods and solutions are available and will apply them to analyze the basis behind the postulatory method of quantum mechanics and which forms the foundations for advanced study of the subject
- Apply principles and laws of equilibrium thermodynamics to multicomponent systems.
- use spectroscopic data to calculate thermodynamic properties of ideal gases, real gases, solids and metals using the principlesand techniques of statistical thermodynamics.

M.Sc. I Semester

COURSE NAME: COMPUTER FOR CHEMISTS – THEORY

CLASS - M.SC CHEMISTRY

Code : (H-1012)

Objective of the Course:

This course aims at acquainting students with learn various concepts and basic techniques essential for conduct of practical in computers

Course Outcomes:

A. Knowledge and understanding:
- Basic understanding about Computer
- Understanding the basic concept associated with C- Language and program designing
- Students will develop different programs, Run and Retrieve results.

B. Intellectual (Cognitive/Analytical) skills:
- Design program in C-language on the basis of given query.
- Use of data structures in C

C. Practical skills:
- Use of standard input (scanf) and standard output (printf) functions
- Use of variables, keywords, arithmetic operators, relational operators, logical operators, unary operators, assignment operator, arithmetic assignment operators and conditional operator.
- Use of library functions and user defined functions.
- Use of Looping Statement (like while, do-while, for loops) and branching statements (like if, ifthen, if-then-else).
- Create functions and to show different calls: Call by reference, Call by value.
- In future student may be able to develop a big program(s)(Software) which may simulate the behavior of the chemical reaction/processes/events

M.Sc. I Semester

COURSE NAME: MATHEMATICS FOR CHEMISTS

CLASS - M.Sc. CHEMISTRY

Code : (H-1010)

Course Objectives:

This course introduces the math content to chemistry students. It has been designed to compliment lecture material with particular focus on the application of math's in chemistry.

Course Outcomes:

A. Knowledge and Understanding:

Students will be able to know –

- Matrix and its types, Determinant and its properties.
- Define the derivative and integral of the trigonometric, logarithmic and inverse trigonometric and rational functions
- Recognize the different techniques of integration (by parts, trigonometric integrals, partial fractions). definite integrals

B. Intellectual(cognitive/Analytical) skills:

- Calculate the rank of matrix
- Determine derivatives of function using different techniques.
- Evaluate integrals by different methods of integration.
- Calculate the areas of plane regions.

C. Practical skills:

- Have the ability to carry out complex calculations orally and mentally.
- Present mathematics to others in oral and written form clearly and in a well-organized manner

COURSE – BIOLOGY FOR CHEMIST (CODE – H-1011)

M.Sc.- I Semester

The purpose of this course is to make the chemist aware of basic principles of biology and biochemistry. From origin of life to biomolecules and their metabolism is covered in this course. Here origin of life, cell structure and their functions, eukaryotic and prokaryotic cell, carbohydrates, amino acids, proteins, nucleic acids, everything is discussed. Again, metabolism of carbohydrates, fats and lipids, etc. also taught to make the students aware of biochemical aspect of science. This course provides a concise coverage of various aspects of biochemistry and molecular biology.

After studying this course students should be able to

1. Understand the basic aspects of biology, origin of life, structure and functions of prokaryotic and eukaryotic cells.
2. Explain the structure and functions of monosaccharides, disaccharides and polysaccharides with examples, basics of carbohydrate metabolism like kreb cycle, glycolysis, etc.
3. Understand the structure and functions of fatty acids, triglycerides, phospholipids, cholesterol, bile acids. They will also understand the metabolism of lipids.
4. Describe the structure and functions of amino acids and protein along with amino acid metabolism.
5. Explain the structure and function of nucleic acids with nucleotides metabolism, chemical basis for heredity, replication of DNA, transcription, translation and genetic code.

COURSE: INORGANIC CHEMISTRY PRACTICAL (CODE – H- 507)

M.Sc.- I Semester

After studying and practice of practical in this course students should be able to

1. Describe the separation of metal ions by paper chromatography for example separation of Ni(II), Co(II), Mn(II), Zn(II), Pb(II), Hg(II), As(III), Sb(III), Sn(II), Fe(III), Cr(III), and Al(III) ions.

2. Prepare the inorganic compounds like

   Hexa-amine Nickel(II) chloride,
   potassium di aquobisoxalato cuprate(II),
   hexamine cobalt(III) chloride,
   tetramine cupric sulphate,
   sodium ferrioxalate,
   potassium chromi oxalate and
   potassium tris-oxalato aluminate, etc.

Course - organic chemistry

paper - Practical

M.Sc. chemistry I semester

Code : (H-507)

A - The systematic analysis of two component (binary mixture) mixture involve the following points :

1 - Nature of mixture

2 - Separation of mixture especially by water.

3 - Systematic analysis and identification of the components.

B - Students will be able to estimate the reagents and amounts of reagents required in different reactions.

C - Students will be able to synthesise new compounds from well known and simpler organic compounds.

M.M. COLLEGE, MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: INORGANIC CHEMISTRY
CLASS: M.Sc.SEMESTER- II
PAPER CODE: H-2007 Ext. = 50
MAX.MARKS: 100 Internal = (2×15+2×5+10=50)

Course Description:

This course is an introduction to Advance inorganic chemistry. Topics include Electronic spectra and megnetic properties of transition metal complexes, and metal"complexes,metal cluster and nuclear chemistry.

Course Objectives:

- Advanced Inorganic Chemistry", R.D.Madan
- "Inorganic Chemistry", P.L. Soni
- The above books are prescribed texts for second semesters.
- To explain the charge transfer spectra
- To explain the concepts Discuss terms, state & microstate & orgel and Tanabe Sugano diagram and calculate microstate & terms of different configurations.
- To understand the megnetic moment, megnetic exchange, spin cross over.
- To explain the term metal carbonyl, prepration, properties and vibrational spectra.
- To explain the term metal nitrosyl and dinitrogen and dioxygen complexesand tertiary phosphine as ligand.
- Discuss classification of clusters and different structural patterns of metal clusters .
- To know the types of nuclear reactions and its applications.To calculate half life period and average life period.

Course Outcome (COs):

Upon successful completion students should be able to:

- CO1 Calculate magnetic moment.
- CO2 Discuss terms, state & microstate & orgel diagram and Tanabe Sugano diagram calculate microstate & terms of different configurations.
- CO3 Discuss classification of clusters and different structural patterns of metal clusters.
- CO4 Explain how low nuclearity clusters differ from high nuclearity clusters and capping rules in metal clusters

.CO5 Basic knowledge of nuclear structure, stable and unstable atomic nuclei, nuclear reactions and different modes of radioactive decay and also methods for measurements of radioactivity.

•CO6 Skills in handling and measurement of radioactive material.

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M.Sc- Chemistry II Semester

Organic chemistry - II

Code : (H-2008)

The course is an introduction to little bit more Advanced organic chemistry. The different topics included in the course are Aromatic Electrophilic substitution, Aromatic Nucleophilic substitution, Free radical reactions, Addition to carbon-carbon and carbon ✱ - Hetero multiple bonds, Elimination and Pericyclic Reactions.

Course outcomes:

After studying these topics the students will be able to understand the nature and mechanism of different reactions in aromatic compounds. They will be also able to know about reaction intermediates and pericyclic reactions.

M.Sc. II Semester

Physical Chemistry II

Code: (H-2009)

1. Chemical Dynamics

Methods of determining of rate laws, Collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory, ionic reactions, kinetic salt effects, steady effect kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.

Dynamic chain (hydrogen-bromine reaction, phyrolysis of acetaldehyde, decomposition of ethane) and photochemical reactions (H_2 - Br_2 and H_2–Cl_2) and oscillatory reactions (Belousov-Zhabotinsky reaction), homogeneous catalysis, Kinetics of enzyme reactions, General features of fast reactions Study of fast reactions-study by flow method, flash photolysis and the nuclear magnetic resonance method.

Dynamics of molecular motions, probing the transition state, dynamics of unimolecular reactions (Lindemann theory, RRKM theory)

2. Surface Chemistry

A. **Adsorption** Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Vapour pressure of droplet (Kelvin equation), Gibbs adsorption isotherms, estimation of surface area (BET equation), Elementary treatment of BET equation, catalytic activity at surfaces.

B. **Micelles** Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactant, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro emulsion , reverse micelles.

C. **Macromolecules** Polymer – definition, types of polymer, kinetics of radical polymerization, mechanism of polymerization

Molecular mass, number and mass average molecular mass, molecular mass determination (Elementary treatment of osmometry, viscometry, sedimentation and light scattering methods), chain configuration of macromolecules, calculation of average dimensions various chain structures.

3. Electrochemistry

Electrochemistry of solutions. Debye-Huckel-Onsager treatment and its extension, ion solvent interactions, Debye-Huckel- Jerum mode. Thermodynamics of electrified interface equations, Derivation of electro-

capillarity, Lippmann equations (surface excess), method of determination. Structure of electrified interfaces, Guoy-Chapman, Stern.

Over potential, Exchange current density ,Derivation of Butler- volmer equation, Tafel plot

Quantum aspects of charge transfer at electrode – solution interfaces, quantization of charge transfer, tunnelling. Semiconductor interfaces- theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces

Electrocatalysis- influence of various parameters, Hydrogen electrode, Bioelectrochemistry, Polarography theory, ILKOvic equation, half wave potential and its significance

Introduction to corrosion, homogeneous theory, forms of corrosion, corroision monitoring and prevention methods

Learning Outcomes

This course aims at acquainting students with the knowledge of various concepts and theories related to physical chemistry.

- After studying these topics the students willbe able to.
- equip with necessary chemical knowledge concerning the concept of reaction rates and electro analytical techniques
- bring forth the importance of academic and laboratory skill
- understand the fundamentals of Chemical dynamics and Voltammetry and their applications.

M.M. College Modinagar
Department of Chemistry
paper : Solid State and Spectroscopy
Class : M.Sc. -IInd Sem.
Paper Code: H-2010

The purpose of this course is to find out the relationship between structural features and physical properties of the compounds. Many recent successes in the determination of the structures of complex natural products would have remained out of reach without them and their contribution in widening our understanding of the reactivity of organic compounds can hardly be overestimated. This gives elementary introduction to the absorption techniques in spectroscopy

After studing this course students should be able to understand -

1. Point groups, plane of symmetry, symmetry elements symmetry operations, group, subgroups, Orthogonality theorem.
2. About Ultra-violet spectroscopy, Lambert-Beer's law and its application with the effect of solvent on electronic transition.
3. Infrared spectroscopy, its instrumentation and sample handling.

4) Nuclear Magnetic Resonance spectroscopy, chemical shift, chemical exchange, shielding mechanism etc.
5) Carbon-13 NMR spectroscopy
6) Basic principles of electron spin resonance spectroscopy, Hyperfine coupling.
7) Raman spectroscopy, rotational and vibrational spectroscopy, Raman Effect, Coherent anti-stokes Raman Spectroscopy (CARS) etc.
8) Atomic absorption spectroscopy
9) Flame Emission Spectroscopy
10) Emission spectroscopy and X-ray methods
11) Mossbauer Spectroscopy.

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COURSE: INORGANIC CHEMISTRY PRACTICAL (CODE – H- 607)

M.Sc.- II Semester

This course involves quantitative inorganic analysis.

After studying and practice of practical in this course students should be able to

1. Perform the volumetric analysis like

   (a) complexometric titration (Mg^{2+} Vs EDTA),
   (b) pH-metry,
   (c) acidimetry and alkalimetry (Neutralization titrations e.g., Na_2CO_3-HCl),
   (d) oxidation and reduction titration (Redox-titrations like $H_2C_2O_4$ Vs $kMnO_4$, $FeSO_4(NH_4)_2SO_4.6H_2O$ Vs $kMnO_4$, $FeSO_4(NH_4)_2SO_4.6H_2O$ Vs $K_2Cr_2O_7$),
   (e) iodometry and iodimetry titration ($CuSO_4$ Vs $Na_2S_2O_3$, $K_2Cr_2O_7$ Vs $Na_2S_2O_3$) and
   (f) precipitation titration ($AgNO_3$ Vs NaCl)

2. Understand the gravimetric analysis i.e., estimation of two constituents for example
   (a) Copper & Nickel
   (b) Iron & Nickel

Course : organic chemistry

Paper : Practical

M.sc. II semester (Chemistry)

Code : ~~(H-606)~~ (H-607)

A- The systematic analysis of binary mixture (organic) involves the following points:

1- Nature of mixture.

2- Separation of binary mixture especially by $NaHCO_3$, NaOH and HCl etc.

3- Systematic analysis ~~of~~ and identification of different components present in the mixture.

B- Students will be able to synthesise bigger molecules from starting simpler molecules in more than one steps. They will also learn that how a functional group can be protected during synthesis.

COURSE -PHOTOCHEMISTRY

PAPER- I Code H-3007

M.Sc-III semester

Photochemistry is the branch of chemistry concerned with the chemical effects of light. In nature; photochemistry is of immense importance as it is the basis of photosynthesis, vision, and the formation of vitamin D with sunlight. Photochemical reactions proceed differently than temperature-driven reactions. This course gives detail information of photochemistry some are as follows:

Chapter-1- Basic of Photochemistry, excitation, photochemical laws, Franck-Condon principle and photochemical stages.

Chapter-2- Photochemical Reactions Interaction of electromagnetic radiation with matter, types of excitations, , quantum, yield, actinometry.

Chapter-3- Photochemical kinetics, Bimolecular deactivation quenching.

Chapter-4:- Types of photochemical-photo-dissociation, gas-phase photolysis.

Chapter-5- Photochemistry of Alkenes, rearrangement of 1, 4 and 1, 5-dienes,

Chapter- 6- Photochemistry of Carbonyl compounds, Paterno buchi Reaction.

Chapter-7- Photochemistry of Aromatic Compounds Isomerisations, additions and substitutions.

Chapter-8- Miscellaneous Photochemical Reactions, Photochemical formation of smog, Photo degradation of polymers, Photochemistry of vision.

After completing the course the student should be able to

(i) Explain theory and practice of common photochemical and photo physical methods, and be able to execute these experimentally.
(ii) Describe the interaction of excited states with their surroundings, and apply theoretical methods for treating excited states.
(iii) Explain the mechanisms of common photochemical transformations, analyze them theoretically, and describe the significance of photochemical reactions
(iv) Explain the properties of excited states. Determination of reaction mechanism and photochemistry of alkenes and carbonyl compounds.
(v) Explain photo catalytic systems using a theoretical framework, and describe typical photo catalytically reactions.
(vi) Explain theory and application of photo catalysis and explain the environmental impact of atmospheric photochemistry.

COURSE – BIO CHEMISTRY PRACTICAL

M.Sc. – III Semester

After studying and practice of practical in this course, student should be able to

(i) Understand the Qualitative test for carbohydrates such as Molish ,Benediet, Barfoed, Fehling test etc.

(ii) Determine the Saponification and acid vaue of oils and fats.

(iii) Understand the Qualitative test for amino acids and proteins.

(iv) Separate the plant pigments by TLC

This can be very useful in research and in synthesis.

M.Sc. Chemistry III - Semester

Paper / course : Spectroscopy

Paper code : (H-3008)

This course includes the studies of different spectroscopies e.g. Inorganic spectroscopies (Vibrational and electron spin resonance spectroscopy etc.) and organic spectroscopies (e.g. UV, IR, ORD & CD, NMR, Carbon-13 NMR and Mass spectroscopies etc.).

After going through the course the students will be able to understand about electromagnetic radiations and its interaction with the matter. By this the students will be able to familiar with the basic concepts of different spectroscopies. Finally these techniques will be helpful to the students in the elucidation of structures of the compounds in the light of spectral data.

M.M. College Modinagar
Department of Chemistry
Paper : Analytical Chemistry
Class : M.Sc. IIIrd Sem.
Paper Code : (H-3009)

The purpose of this course is to make the chemist aware of modern analytical chemistry. Actualy analytical chemistry is the science of measurement and instrumentation. This is the only branch of experimental science which involves a large number of measurement followed by intensive calculations. This deals with qualitative as well as quantitative analysis

After studing this course students should be able to understand -

1) Basic role of analytical chemistry with laboratory functioning, glasswares and reagents.
2) Mean, median, precision, standard deviation, accuracy, errors and their types.
3) Definition of radioactivity, radioactive decay instrumentation, autoradiography, radioisotopes, Neutron activation analysis (NAA) and Isotopic Dilation (IDA) and radiometric titrations.

4) Meaning of thermal methods of analysis, thermogravimetry its application, Derivative thermogravimetry (DTG), Differential Scanning Calorimetry (DSC) and thermometric titrations

5) Definition of chromatography, its types, paper chromatography, HPLC, HPTLC, Gas chromatography and ion-exchange chromatography.

6) About voltametry its types and applications, Polarography its types and instrumentation.

7) About ion-selective electrodes.

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COURSE: BIO-ORGANIC CHEMISTRY (CODE – H-3011)

M.Sc.- III Semester

With spectacular developments in chemical sciences all five branches have merged with each other to provide new vistas in chemistry like Bio-organic chemistry. With newer developments in life sciences, biosciences have shown new discoveries especially useful for well-being of mankind. In future biosciences are likely to come to for front as the useful science for the human being. Currently tremendous research is going on biosensor and enzyme therapy and this area has great potential to fight with various unsolved problems related to health. Enzymology in-inviteably involves a certain amount of Elementary Mathematics. The course is intended beneficial mainly for students taking substantial biochemistry component, biological sciences, biomedical science or forensic science. With the emergence of biotechnology as the science of the 21st century, enzymology has become an epicenter of a range of new activities. Bio-organic chemistry/enzymology is a new emerging branch of technology having immense potential apart from traditional teaching. Bio-organic chemistry is a scientific discipline that combines organic chemistry and biochemistry dealing with the study of biological processes using chemical methods. Proteins and enzymes are examples of the recursive these processes. This course gives a broad account of enzymology and aims to put the current knowledge into perspective. The course covers the properties of isolated enzymes, structural characterization, kinetics, catalytic action and control of activity, immobilization methods and various application of enzymes. The method of isolation and characterization of enzymes are well established procedures, so the rate at which three-dimensional structures and mechanisms are being determined is increasing dramatically.

After studying this course students should be able to

1. Understand the chemistry of amino acids and proteins nucleosides, nucleotides, DNA and RNA.
2. Explain the historical perspective of enzymes, chemical and biological catalysis, properties of enzymes like catalytic power, specificity, and regulation. Also, they understand nomenclature of enzymes, their purification and extraction. Fisher's lock & key and koshland's induced fit hypothesis, identification of active sites using inhibitors. Enzyme modification by site directed mutagenesis. Also, they came to no enzyme kinetics reversible and irreversible inhibition.
3. Understand the mechanism of enzymes by taking examples like chymotrypsin, ribonuclease, lysozyme, and carboxypeptidase A.
4. Explain different kind of reactions catalyzed by enzymes like addition reaction, elimination reaction, rearrangement reaction and carboxylation & decarboxylation.
5. Explain co-enzymes, prosthetic groups, apoenzymes, structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, etc. Mechanism of reaction catalyzed by the cofactors.
6. Describe the host-guest chemistry, molecular recognition, molecular asymmetry and prochirality. They also explain biomimetic chemistry, crown ethers, cryptates, cyclodextrins etc.
7. Explain the production and purification of enzymes, techniques and method of immobilization of enzymes, clinical uses of enzymes, enzyme therapy recombinant DNA technology and application of enzymes in organic synthesis.

M.Sc III Semester Paper - Biophysical Chemistry Paper code: H-3012

Course Content

1. Introduction: Chemistry of amino acids proteins and their derivatives; methods of isolation and identification; Primary, secondary, tertiary and quaternary structures of proteins; determination and biochemical applications of the structures of proteins; Nomenclature of nucleosides and nucleotides; Effects of acid and alkali on hydrolysis of nucleic acids ; Structure of DNA and RNA ; prokaryotic versus eukaryotic organisms.

2. Biological Cell and its' Constituents: Biological cell, Structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition.

3. Bioenergetics: Standard Free energy change in biochemical reactions, exergonic, endergonic Hydrolysis of ATP, synthesis of ATP from ADP.

4. Statistical Mechani in Biopolymers: Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures, introduction to protein folding problem.

5.Biopolymer interactions: Forces involved in biopolymer interactions. Electrostaic charges, and molecular expansion, hydrophobic forces. Dispersion force interactions. Multiple equlibria and various types of binding processes in biological systems. Hydrogen ion titration curves. DNA Protein Interaction.

6. Thermodynamics of Biopolymer Solutions: Thermodynamics of biopolymer soluctions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechnochemical system.

7. Cell Membrane and Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

8. Biopolymers and their molecular Weights Evaluation of size, shape molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, hydrodynamic methods, diffusion. Sedimentation velocity, viscosity, electrophoresis and rotational motions.

Learning Outcomes

After studying this course students will be able to:

- Account for the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.
- Account for basic concepts within statistical thermodynamics and molecular simulation, and apply this to macromolecular systems.
- Account for structures and functions of biological membranes, as well as model systems and relevant methods for the study of these structures and functions.

- Explain and apply methods for the determination of functional molecular mass of biological macromolecules in solution as well as determination of equilibrium - and rate constants for macromolecule-ligand interactions.
- account for and apply spectroscopic methods for the study of structures and functions in biological systems

M.M. College Modinagar
Department of Chemistry
Paper - Analytical Chemistry Practical
Class - M.Sc. IInd Sem.
Paper Code - H-707

After studing and practice of practical in this course the students should be able to —

1) To verify Lambert's - Beer's Law with the help of U.V. visible spectrophotometer.
2) To determine λ_{max} of a given sample
3) To determine the concentration of unknown sample with the help of U.V. visible spectrophotometer
4) To scan the U.V. visible spectra of unknown sample with the U.V. visible double-beam spectrophotometer.
5) To determine the ~~dynamic~~ kinematics viscosity of polymeric plasticizer with the help of Redwood viscometer.
6) To separate the chlorophyll pigments with the help of paper chromatography.

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M.M. COLLEGE, MODINAGAR

DEPARTMENT: CHEMISTRY
SUBJECT: ENVIRONMENTAL CHEMISTRY
CLASS: M.Sc. SEMESTER-IV
PAPER CODE: H-4007
MAX MARKS: 100 Internal = (2×15 + 2×5 + 10 = 50); External = 50

1. Environmental chemistry is the study of chemical process occuring in the environment which are impacted by human kinds activities. Environmental chemistry include understanding chemical reaction and equations, solutions, units, sampling and analytical techniques.

2. Environment chemists study the behaviour of pollutants and their environmental effects on the air,water and soil environment as well as their effects on human health and the natural environment.

Learning objectives

The aim of the course is to provide the fundamental knowledge concerning the chemical-physical characteristics of the three matrices air, water and soil as well as knowledge inherent to the main environmental pollutants present. Finally, another objective is to illustrate possible methods of cleaning up pollution, also clarifying the policies to be implemented for environmental protection and sustainability.

Expected learning outcomes

At the end of the learning process the student will have to acquire knowledge concerning the chemical-physical characteristics of the three environmental matrices (air, water and soil) and the mechanisms of interaction between them.

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COURSE – ORGANIC SYNTHESIS (CODE – H- 4013)

M.Sc.- IV Semester

Organic synthesis is a creative science which teaches us how to make molecules. It plays pivotal role in most of the improvements in the quality of our life. Chemists synthesize compounds in almost all chemistry laboratories in the world. Industrial chemists synthesise pharmaceuticals, pesticides, agrochemicals, polymers, detergents, and disinfectants. Research chemists synthesise natural products whose structure is uncertain, compounds for mechanistic investigations, possible intermediates in chemical and biological processes, thousands of potential drugs which is in clinical use and even compounds which might themselves be useful for organic synthesis. This course is designed to understand a large number of reactions, rearrangements and reagents important for future chemist. Organic synthesis is a special branch of chemical synthesis and is concerned with the intentional construction of organic compounds. Each step of synthesis involves a chemical reaction and reagents and conditions for each of these reactions must be designed to give an adequate yield of pure product. In organic synthesis, organic reactions are used in the construction of new organic molecules. The production of many man-made chemicals such as drugs, plastics, food additives, fabric depend on organic reactions.

After studying this course students should be able to

1. Understand the chemistry of organometallic reagents their preparation, properties and applications in organic synthesis.
2. Explain the different oxidation reactions and their mechanism with examples of oxidation with ruthenium tetroxide iodobenzene diacetate and thallium nitrate.
3. Explain the reduction of organic compounds like hydrocarbons, aldehydes, ketones, acids, etc. with mechanism.
4. Explain the different rearrangement reaction with mechanism.
5. Describe non-benzenoid aromatic and polycyclic aromatic compounds.

COURSE - POLYMERS

PAPER- Organic Chemistry Special III Code H-4015

M.Sc-IV semester

Polymers are long chain molecules with properties dominated by their chain behavior and the nature of their chemical make-up or constitution. The distinction between thermoplastics and thermo sets has become rather blurred with the development of new materials for more demanding environments than previously. They include high performance polymers which are more resistant to high temperatures, possess greater moduli or strengths, and can be combined with additives to enhance their intrinsic properties yet further. An understanding of the atomic and molecular construction of polymers provides an insight into how improved materials can be developed, in the subject of molecular engineering. It includes an understanding of both molecular configuration and conformation. This course gives detail information of polymer as follows:

Chapter-1: Explain the basic concepts and importance of polymers.

Chapter-2: Explain the polymer characterization.

Chapter-3: Deals with properties and general methods of structural elucidation of polymers.

Chapter-4: Comprises the processing of different polymers.

Chapter-5: Elaborate the properties and uses of commercial polymers.

After studying this course, Students should be able to:

(i) Estimate the number- and weight-average molecular masses of polymer samples given the degree of polymerization and mass fraction of chains present.

(ii) Isolate the key design features of a product which relate directly to the material(s) used in its construction and other industries.

(iii) Indicate how the properties of polymeric materials can be exploited by a product designer.

(iv) Describe the role of rubber-toughening in improving the mechanical properties of polymers.

(v) Identify the repeat units of particular polymers and specify the isomeric structures which can exist for those repeat units.

COURSE -CHEMISTRY OF NATURAL PRODUCT

PAPER- Organic Chemistry Special IV Code H-4016

M.Sc-IV semester

Throughout our evolution, the importance of natural products for medicine and health has been enormous. Since our earliest ancestors chewed on certain herbs to relieve pain, or wrapped leaves around wounds to improve healing, natural products have often been the sole means to treat diseases and injuries. This course contains different types of natural products and their chemistry and medicinal importance. This course gives detail information of natural product as follows:

Chapter-1: Explain the importance of terpenoid and carotenoids as lead molecules for new drug discovery.

Chapter-2: Explain the history and importance of alkaloids as lead molecules for new drug discovery.

Chapter-3: Deals with steroids and hormones and general methods of structural elucidation of steroids and hormones.

Chapter-4: Understand isolation, purification and characterization of Plant Pigments.

Chapter-5: Elaborate methods of structural elucidation of Hemoglobin and chlorophyll.

Chapter-6: Explain Chemistry and Physiological significance of Prostaglandin

The intellectual ferment of chemical enquiry began with the man's ability to notice, observe, and reflect on things around him and with his interest and appreciation for beautiful colors, flavors, fragrance, taste, and medicinal and curative properties of plants. Thus from the dawn of civilization Nature has been appearing to be an enigma to human beings because of their innate curiosity. The study of natural products offers an excellent strategy toward identifying novel biological probes for a number of diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a number of diseases including cancer and infection.

COURSE – ORGANIC CHEMISTRY Code: (H-807)

PAPER-PRACTICAL

M.Sc. – IV Semester

The Systematic analysis of three component mixture involves the following points.

1. Nature of the mixture
2. Type of the mixture
3. Separation of the mixture into three components.
4. Systematic analysis of each component which involves following
   a) Preliminary Tests.
   b) Detection of elements.
   c) Detection of the functional group.
   d) Physical constants. (M.P & B.P.)
   e) Conformation with preparation of derivatives.
   f) Result

After studying and practice of practical in this course, student should be able to separate the ternary mixture with water and $NaHCO_3$, water and NaOH, water and HCl. After the separation they can identify compounds present in the mixture. This can be very useful in research and in synthesis.

Course - organic chemistry

Paper - Practical

M.Sc. Chemistry IV semester

Code : (H-807)

Three step organic preparations/syntheses :

The three step organic syntheses involve the following points :

1- we have to be careful in handling organic compounds especially organic solvents.
2. Regarding melting and boiling points of different organic compounds.

After studying and practice of practicals in the course, students will be able to synthesise complex compounds from indigenous starting materials like benzophenone and thiourea etc. They will be able to apply theory in practice. This can be very useful in research and in synthesis.

M.Sc IV Semester

Paper:-Physical Chemistry Special-I (Solid State Chemistry) Code : (H-4018) ~~(H-4021)~~ MQ

Course Content

I. Solid State Reactions

General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

II. Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky defects and Frenkel defects. Thermodynamics of schottky and

III.Electronic Properties and Band Theory

Metals, insulators and semiconductors, electronic structure of solids-band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Optical Properties- Optical reflectance, photoconduction-photoelectric effects. Magnetic properties-Classification of materials : Quantum theory of paramagnetics- cooperative phenomena- magnetic domains, hysteresius

IV. Organic Solids

Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors.

V. LASERS

Luminescence and lasers

VI. Recent trends in solid state chemistry

Learning Outcomes

This course provides a background of the basic principles of symmetry and crystal structures investigated through diffraction and scattering methods in structure determination of crystalline, amorphous, organic materials a. In addition, students will learn about the electronic and magnetic properties of metals and semiconductors.

Physical Chemistry Special-III (Liquid State) (Code: H-4020)

I. General Properties of Liquids

(a) Liquids as dense gases, liquids as disordered solids, some thermodynamic relations, internal pressure and its significance in liquids, Equation of state, critical constants. Different types of intermolecular forces in liquids, different potential functions for liquids, additivity of pair potential approximation.

(b) A classical partition function for liquids, correspondence principle, configuration integral, configurational properties

II. Theory of Liquids

Theory of liquids, partition function method or model approach; single cell models, communal energy and entropy, LTD model, significant structure model.

III. Distribution Function and related Equations

Radial distribution function method, equation of state in terms of RDF. Molecular distribution functions, pair distribution function. Relationship between pair distribution function and pair potential function. The IBG equation, the HNC equation, the PY equation, cluster expansion.

IV. Methods for Structure Determination and Computational Techniques

Spectroscopic techniques for liquid dynamic structure studies, Neutron and X-ray scattering spectroscopy. Computation Techniques- Monte Carlo and molecular dynamics methods

V. Supercooled and Ionic Liquids

Supercooled and ionic liquids, theories of transport properties; non Arrhenius behaviour of transport properties, Cohen-Turnbull free volume model, configurational entropy model, Macedo-Litovitz hybrid model, glass transition in supercooled liquids

Learning Outcomes

This course will provide an advanced level in-depth understanding about the properties of liquids, various statistical theories of liquids and their applications. Theories of supercooled and ionic liquids. Students will also learn about spectroscopic and various computational methods for the structural studies of liquids.

Code : (H-4021)

Physical Chemistry Special-IV (Physical Chemistry in Organic reactions)

I. Concepts in Molecular Orbital (MO) and Valence Bond (VB) theories

Introduction to Huckel Molecular Orbital (MO) method as a means to explain modern theoretical methods. Advanced techniques and FMO theory. Molecular mechanics, semi empirical methods and ab initio and density functional methods. Scope and limitations of several computational programmes. Quantitative MO theory – Huckel molecular orbital (HMO) method as applied to ethane, allyl and butadiene. Qualitative MO theory- ionization potential. Electron affinities. MO energy levels. Orbital symmetry. Orbital interaction diagrams. MO of simple organic systems such as ethane, allyl, butadiene, methane and methyl group. Conjugation and hyperconjugation. Aromaticity. Valence bond (VB) configuration mixing diagrams. Relationship between VB configuration mixing and resonance theory. Reaction profiles. Potential energy diagrams. Curve- crossing model- nature of activation barrier in chemical reactions.

II. Principles of Reactivity

Mechanistic significance of entropy, enthalpy and Gibb's free energy, Arrhenius equation. Transition state theory. Use of activation parameters, Hammond's postulate. Bell-Evens-polanyi principle. Polential energy surface model. Marcus theory of electron transfer. Reactivity and selectivity principles.

III. Kinetic Isotope effect

Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect. Solvent effects.

IV. Structural Effects on Reactivity

Linear free energy relationships (LFER). The Hammet equation, substituent constants, theories of substituent effects. Interpretation of σ-values. Reaction constant ρ. Deviations from Hammet equation. Dual-parameter correlations, inductive substituent constant. The Taft model. σl- and σRscales.

V. Solvation and Solvent Effects

Qualitative understanding of solvent-solute effects on reactivity. Thermodynamic measure of salvation. Effects of salvation on reaction rates and equilibrium. Various empirical indexes of salvation based on physical properties, solvent-sensitive reaction rates, spectroscopic properties and scales for specific solvation. Use of solvation scales in mechanistic studies. Solvent effects from the curve crossing model.

VI. Acids, Bases, Electrophiles, Nucleophiles and Catalysis

Acid-base dissociation. Electronic and structural effects, acidity and basicity. Acidity functions and their applications.Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The σ-effect. Ambivalent nucleophiles. Acid-base catalysis-specific and general catalysis. Bronsted catalysis. Nucleophilic and electrophilic catalysis. Catalysis by non-covalent binding-micellat catalyst.

VII. Steric and Conformational Properties

Various types of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates. Steric LFER. Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammet principle.

Learning Outcomes

After studying thiscourse the students will be able to:

- apply qualitative electronic structure theory to predict the geometric structure, reactivity and other properties of organic molecules and to apply qualitative theoretical models to describe pericyclic reactions.
- predict conformational preference of organic molecules and the stereochemical preference in reactions
- critically evaluate and apply different techniques (experimental and computational) for the determination of mechanisms of organic reactions
- predict the influence of solvent on reactivity
- describe important processes of organic molecules in electronically excited states

M.Sc. Chem. IV Semester
Course: Practical in Physical Chemistry
Code: (H-807)

Physical Chemistry Practical

A: Chemical Kinetics

1. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the Initial Rate Method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.

2. Compare the strengths of hydrochloric acid and sulphuric acid by studying the rate of hydrolysis of methyl acetate.

3. Study the saponification of ethyl acetate with sodium hydroxide volumetrically.

4. Determine the specific reaction rate of the potassium persulphate-iodide reaction by the Initial Rate Method.

5. Study the kinetics of the iodination of acetone in the presence of acid by the Initial Rate Method. 6. (a) Determine the specific rotation constant for sucrose.

(b) Study the acid catalyzed inversion of cane sugar, and find out (i) the order with respect to sucrose; (ii) the rate constant; (iii) Compare kinetically the strengths of two acids (HCl and H2SO4)

B: Conductometry

1. Determine the Cell Constant of the given conductivity cell at room temperature and study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).

2. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.

3. Determine the equivalent conductance, degree of dissociation and dissociation constant (Ka) of acetic acid.

4. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in a commercial sample of soda ash.

5. Study the conductometric titration of (i) Acetic acid vs. sodium hydroxide, (ii) Acetic acid vs. ammonium hydroxide, (iii) Sodium acetate vs. HCl, Comment on the nature of the graphs.

6. Study the stepwise neutralization of a polybasic acid e.g. oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the plots.

7. Study the conductometric titration of a mixture of a strong and weak acid.

8. Study the estimation of potassium sulphate solution by conductometric titration.

C: Potentiometry

1. Prepare and test the Calomel Electrode.

2. Titrate hydrochloric acid and sodium hydroxide potentiometrically.

3. Determine the dissociation constant of acetic acid potentiometrically.

4. Titrate oxalic acid and sodium hydroxide potentiometrically.

5. Titrate a mixture of (i) strong and weak acids (Hydrochloric and acetic acids) (ii) weak acid (acetic acid) and dibasic acid (oxalic acid) (iii) strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodium hydroxide.

6. Titrate a solution of Mohr's salt against potassium permanganate potentiometrically.

7. Titrate a solution of Mohr's Salt and potassium dichromate potentiometrically.

D: Computational Methods

Familiarity with word processing, electronic spreadsheets, data processing, mathematical packages, chemical structure drawing and molecular modelling.

E: Thermodynamics

1. Determination of partial molar volume of solute (e.g.KCl) and solvent in a binary mixture.

2. Determination of the dependence of the solubility of a compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO-water mixture) and calculate the partial molar heat of solution.

F: Spectroscopy

1. Determination of pKa of an indicator (e.g., methyl red) in (a) aqueous and (b) micellar media.

2. Determination of stoichiometry and stability constant of inorganic (e.g. ferric-salicylic acid) and organic (e.g amine-iodine) complexes.

3. Characterization of the complexes by electronic and IF spectral data.

Learning Outcomes

After successfully completing this course, students will be able to:

- Design experiments in Physical Chemistry and Analytical Chemistry using potentiometry, conductometry, fluorimetry, colorimetry, kinetics and chromatography
- Apply concepts of Physical Chemistry and Analytical Chemistry through experimentation
- prepare the solution of the desired concentration and the desired volume
- Know the principle and handling of pH meter, Potentiometer, conductivitymeter, spectrophotometer, viscometer,etc.
- Plot accurate graphs of the desired scale for the calculations
- Maintain laboratory ethics, safety and cleanliness
- Understand waste management of the laboratory

B.Sc. - SECOND YEAR

CHEMISTRY

There shall be three written papers and a practical examination as follows :

		Max. Marks
Paper – I	Inorganic Chemistry	50
Paper – II	Organic Chemistry	50
Paper – III	Physical Chemistry	50
	TOTAL	**150**
	PRACTICAL	50
	GRAND TOTAL	**200**

Candidate will be required to pass in Theory and Practical Separately.

B.Sc. – II Chemistry (Paper-I)

Inorganic Chemistry :

Unit – I

I. Chemistry of Elements of First Transition Series

Characteristic properties of d-block elements.

Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.

II. Chemistry of Elements of Second and Third Transition Series

General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Unit – II

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.

Unit – III

IV. Chemistry of Lanthanide Elements

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.

V. Chemistry of Actinides

Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit – IV

VI. Oxidation and Reduction

Electrode potential, electrochemical series and its applications, Principles involved in the extraction of the elements.

VII. Acids and Bases

Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.

VIII. 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.

B.Sc. – II Chemistry (Paper-II)

Organic Chemistry :

Unit – I

I. Electromagnetic Spectrum Absorption Spectra

Ultraviolet (UV) absorption spectroscopy – absorption laws (Beer-Lambert law); molar absroptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. U.V. spectra of conjugated enes and enones.

Infrared (I.R.) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of I.R. bands, measurement of I.R. spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra of simple organic compounds.

Unit – II

II. Alcohols

Classification and nomenclature,
Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols.
Dihydric alcohols - – nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol- pinacolone rearrangement.
Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.

III. Phenols :

Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman syntheis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

Unit – III

IV. Ethers and Epoxides

Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method.
Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

V. Aldehydes and Ketones:

Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties.

Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction.

Use of acetals as protecting group, Oxidation of aldehydes, Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones An introduction to α, β unsaturated aldehydes and Ketones.

Unit – IV

VI. Carboxylic Acids:

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength, Preparation of carboxylic acids, Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction, Synthesis of acid chlorides, esters and amides, Reduction of carboxylic acids, Mechanism of decarboxylation.

Methods of formation and chemical reactions of halo acids, Hydroxy acids: malic, trartaric and citric acids.
Methods of formation and chemical reactions of unsaturated monocarboxylic acids.
Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

VII. Carboxylic Acid Derivatives

Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anyhydrides.

Relative stability of acyl derivatives, Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic acid derivatives, chemical reaction. Mechanisms of esterificaton and hydrolysis (acidic and basic)

VIII. Organic Compounds of Nitrogen:

Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nuclephilc substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid.

Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substituton in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

B.Sc. – II Chemistry (Paper-III)

Physical Chemistry :

Unit – I

(Thermodynamics & Chemical Equilibrium)

I. **Thermodynamics – I**

Definitions of thermodynamic terms :

System, surroundings etc. Types of systems, intensive and extensive properties, State and path functions and their differentials, Thermodynamic processes, concept of heat and work.

First Law of Thermodynamics :

Statement, definition of internal energy and enthalpy, Heat capacity, heat capacities at constant volume and pressure and their relationship, Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isotheral and adiabatic conditions for reversible process.

Thermochemistry :

Standard state, standard enthalpy of formation – Hess's Law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralization, Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy, Kirchhoff's equation

Unit – II

II. **Chemical Equilibrium**

Equilibrium constant and free energy, Thermodynamic derivation of law of mass action, Le Chatelier's principle

Reaction isotherm and reaction isochore – Clapeyron-clausius equation and its applications.

III. **Thermodynamics – II**

Second Law of Thermodynamics :

Need for the law, different statements of the law, Cornot's cycle and its efficiency, Carnot's 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, Equilibrium change in ideal gases and mixing of gases.

Gibbs and Helmholtz functions:

Gibbs function (G) and Helmhotz 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.

Third Law of Thermodynamics:

Nernst heat theorem, statement and concept of residual entropy.

Nernst distribution law – thermodynamic derivation, applications.

Unit – III

(Electrochemistry – I & Solutions)

IV. **Electrochemistry – I:**

Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar equivalent and specific conductance with dilution.

Migration of ions and Kohlrausch's law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law its uses and limitations, Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only),

Transport number, definition and determination by Hittorf's method and moving boundary method.

Applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

V. Solutions:

Liquid – Liquid mixtures- Ideal liquid mixtures, Raoult's and Henry's law, Non-ideal system-azeotropes – HCl-H_2O and ethanol – water systems.

Partially miscible liquids- Phenol – water, trimethylamine – water, nicotine-water systems, Immiscible liquids, steam distillation.

Unit – IV

(Electrochemistry – II & Phase Equilibrium)

VI. Electrochemistry – II:

Types of reversible electrodes – gas-metal ion, metal-ion, metal-insoluble salt-anion and redox electrodes, Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, strandard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, electrochemical series and its significance.

Electrolytic and Galvanic cells–reversible and irreversible cells, conventional representation of electrochemical cells;

EMF of a cell and its measurements, Computation of cell EMF, Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K)

Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

Definition of pH and pK_a, determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods;

Buffers – Mechanism of buffer action, Henderson-Hazel equation, application of buffer solution, Hydrolysis of salts

VII. Phase Equilibrium:

Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibb's phase rule, phase equilibria of one component system-water, 'CO_2' and 'S' systems

Phase equilibria of two component system – solid liquid equilibria simple eutectic – Bi-Cd, Pb-Ag systems, desilverisation of lead.

Solid solutions – compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system

B.Sc. II

Chemistry Practical

Inorganic Chemistry:

Volumetric Exercise

1. Estimation of acetic acid in vinegar by acid- base titration.
2. Titration of Fe^{2+} with dichromate using internal and external indicator.
3. Iodometric estimation of potassium dichromate and copper sulphate.
4. Estimation of Calcium content in Chalk as Calcium oxalate by permangnometry
5. Determination of the concentration (strength) of a given NaOH solution by titrating it against a standard solution of oxalic acid.
6. Determination of the strength of a given solution of dil HCl by titrating it against a standard solution of Na_2CO_3.

Organic Chemistry

Identification of organic compounds containing any one of the following groups – aldehyde, carbohydrate, acid, phenol, ketone, ester, alcohol, amine, amide, nitro, hydrocarbon

This would include determination of melting point, element detection, test for solubility and unsaturation, test for functional group and specific test if any.

Physical Chemistry

Thermometry

1. To determine heat of neutralization of strong acid with strong base.
2. To determine heat of neutralization of strong acid with weak base.
3. To determine heat of neutralization of weak acid with weak base.
4. To determine enthalpy of solution of solid Calcium Chloride and Calculation of lattice energy of $CaCl_2$ by using Born Haber cycle.
5. To determine enthalpy of neutralization and ionization of acetic acid.
6. To determine the enthalpy change for the interaction between acetone and chloroform (hydrogen bond formation)

Minu Sangal

25.10.17

25/10/17

Phase Equilibrium

1. To construct a phase diagram for Naphthalene – Benzoic acid
2. (i) To determine critical solution temperature of Phenol – water system
   (ii) To observe the effect of sodium chloride or critical solution temperature of Phenol – water system.
3. To construct the phase diagram of diphenyl amine – benzophenone by Thaw – melt method / Cooling curve method
4. To determine the distribution coefficient of I_2 in CCl_4 – water system.
5. To determine the distribution coefficient of benzoic acid in toluene – water system.

System of Marking

Duration: 6h (1day)	**M.M: 50**
Exercise 1: Any one volumetric exercise	15
Exercise 2: Identification of one organic compound	15
Exercise 3: Any one Exercise from Physical Chemistry	10
Viva- voce	05
Record (including chart/model)	05

Minu Singh

25.10.17

25/10/17

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B.Sc. - THIRD YEAR

CHEMISTRY

There shall be three written papers and a practical examination as follows:

		Max. Marks
Paper – I	Inorganic Chemistry	75
Paper – II	Organic Chemistry	75
Paper – III	Physical Chemistry	75
	TOTAL	**225**
	PRACTICAL	75
	GRAND TOTAL	**300**

Candidate will be required to pass in Theory and Practical Separately.

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B.Sc. – III Chemistry (Paper-I)

Inorganic Chemistry :

Unit – I

I. **Metal-ligand bonding in Transition Metal Complexes**
Limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters.

II. **Thermodynamic and Kinetic Aspects of Metal Complexes**
A brief outline of thermodynamics stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes.

Unit – II

III. **Magnetic Properties of Transition Metal Complexes**
Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

IV. **Electronic spectra of Transition Metal Complexes**
Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Unit – III

V. **Organometallic Chemistry**
Definition, nomenclature and classification of organometallic compounds,

Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Snl.

Metal carbonyls: 18 electron rule, preparation, structure and nature of bonding in the mononuclear carbonyls.

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

Unit – IV

VII. **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, electro negativity and hardness and softness.

VIII. **Bioinorganic Chemistry**
Essential and trace elements in biological processes, metalloporphyrins with special reference to hemoglobin and myoglobin, Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+}.

B.Sc. – III Chemistry (Paper-II)

Organic Chemistry :

Unit – I

I. Spectroscopy

Nuclear magnetic resonance (NMR) spectroscopy, Proton magnetic resonance (^{1}H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of ^{1}H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1, 2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structures elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic, techniques.

Unit – II

II. Organometallic Compounds

Organomagnesium compounds : the Grignard reagents, formation, structure and chemical reactions.

Organozinc compounds: formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

III. Organosulphur Compounds

Nomenclature, structural formation, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and Sulphaguanidine.

IV. Hetrocyclic Compounds

Introduction : Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophilc substitution reactions of indole, quinoline and isoquinolines.

Unit – III

V. Carbohydrates

Classification and nomenclature, Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides, Erythro and threo diastereomers, Conversion of glucose intro mannose, Formation of glcosides, ethers and esters, Determination of ring size of monosaccharides, Cyclic structure of D(+)-glucose, Mechanism of mutarotation.

Structures of ribose and deoxyribose,

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

VI. Amino Acids, Peptides, Proteins and Nucleic Acids:
Classification, structure and stereochemistry of amino acids, Acid-base behaviour isoelectric point and electrophoresis, Preparation and reactions of α-amino acids, Structure and nomenclature of peptides and proteins, Classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid-phase peptide synthesis, Structures of peptides and proteins, Levels of protein structure, Protein denaturation/ renaturation;

Nucleic acids : Introduction, constituents of nucleic acids, Ribonucleosides and ribonucleotides, The double helical structure of DNA.

Unit – IV

VII. **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.

VIII. **Synthetic Polymers**
Addition or chain-growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers,

Condensation or step growth-polymerization, Polyesters, plyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes, Natural and synthetic rubbers, Elementary idea of organic conducting polymers.

IX. **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.

X. **Organic Synthesis via Enolates**
Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate.

Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.

B.Sc. – III Chemistry (Paper-III)

Physical Chemistry :

Unit – I

(Introductory Quantum Mechanics, Spectroscopy, Physical Properties and Molecular Structure)

I. Introductory Quantum Mechanics:

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (without derivation) their solution of overall solution and its defects, Compton effect, de-Broglie's hypothesis, the Heisenberg's uncertainty principle, Hamiltonian Operator.

II. Spectroscopy:

Introduction : electromagnetic radiation, regions of the spectrum, basic features of different spectrophotometers, statement of the born-oppenheimer approximation, degrees of freedom.

III. Physical Properties and Molecular Structure:

Optical activity, polarization – (Clausius – 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 ferromagnetic, Magnetic susceptibility, its measurements and its importance.

Unit – II

IV. Elementary Quantum Mechanics:

Schrödinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box.

Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions.

Molecular orbital theory, basic ideas – criteria for forming M.O. from A.O., construction of M.O's by LCAO – H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics, Hybrid orbitals – sp, sp^3, sp^2, calculation of coefficients of A.O's used in sp and sp^2 hybrid orbitals and interpretation of geometry.

Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

Unit – III

V. Rotational Spectrum:

Diatomic Molecules: Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

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Vibrational Spectrum :

Infrared 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.

Raman Spectrum : Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

Electronic Spectrum : Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle.

Qualitative description of σ, π and η M.O. their energy levels and the respective transition.

Unit – IV

(Photochemistry, Solutions, Dilute Solutions and Colligative Properties)

VI. **Photochemistry :**

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), Kinetics of Photo chemical reaction.

Solutions, Dilute Solutions and Colligative Properties:

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.

Inorganic Chemistry :

Synthesis and Analysis:

(a) Preparation of sodium trioxalator ferrate (III), $Na_3[Fe(C_2O_4)_3]$ and determination of its composition by permagonometry.
(b) Preparation of Ni-DMG complex, $[Ni(DMG)_2]$
(c) Preparation of copper tetraammine complex. $[(Cu(NH_3)_4]SO_4$.
(d) Preparation of *cis*-and *trans*-bisoxalato diaqua chromate (III) ion.

Instrumentation:

Colorimetry

(a) Job's method (b) Mole-ratio method
Adulteration – Food stuffs.
Effluent analysis, water analysis

Solvent Extraction

Separation and estimation of Mg(II) and Fe(II)

Ion Exchange Method

Separation and estimation of Mg(II) and Zn(II)

Organic Chemistry :

Laboratory Techniques:

Steam Distillation

Naphtalene from its suspension in water
Clove oil from cloves
Separation of *o*-and *p*-nitrophenols

Column Chromatography

Separation of fluorescein and methylene blue
Separation of leaf pigments from spinach leaves
Resolution of racemic mixture of (±) mandelic acid

Qualitative Analysis

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$,
NaOH for separation and preparation of suitable derivatives

Synthesis of Organic Compounds

(a) Acetylation of salicylic acid, aniline, glucose and hydroquinone, Benzoylation of aniline and phenol
(b) Aliphatic electrophlic substitution
Preparation of iodoform from ethanol and acetone
(c) Aromatic electrophilic substitution
Nitration
Preparation of m-dinitrobenzene

Preparation of p-nitroacetanilide

Halogenation
Preparation of p-bromoacetanilide
Preparation of 2, 4, 6-tribromophenol

(d) Diazotization/coupling
Preparation of methyl orange and methyl red

(e) Oxidation
Preparation of benzoic acid from toluence

(f) Reduction
Preparation of aniline from nitrobenzene
Preparation of m-nitroaniline from m-dinitrobenzene

Stereochemical Study of Organic Compounds via Models

R and S configuration of optical isomers
E, Z configuration of geometrical isomers
Coformational analysis of cyclohexanes and substituted cyclohexanes

Physical Chemistry :

Electrochemistry:

1. To determine the strength of the given acid conductometrically using standard alkali solution.
2. to determine the solubility and solubility of a sparingly soluble electrolyte conducometrically.
3. to study the saponification of ethyl acetate condutometrically.
4. To determine the ionization constant of a weak acid condutometrically.
5. To titrate potentiometrically the given ferrous ammonium sulphate solution using $KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{++}/Fe^{+++} system on the hydrogen scale.

Refractrometry, Polarimetry:

1. To verify law of refraction of mixtures (e.g. of glycerol and water) using Abbe's refractometer.
2. To determine the specific rotation of a given optically active compound.
3. To determine stoichiometry and stability constant of complexes.

Molecular Weight Determination:

1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method.
2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy.

Colorimetry:

1. To verify Beer – Lambert Law for $KMnO_4/K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement.

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