

Chhindwara University, Chhindwara (M.P.)

Chemistry

SYLLABUS OF ~~M.A./M.Com./M.Sc./M.H.Sc.~~ ~~PREVIOUS/FINAL~~ OR SEMESTER -----

I

Name of Paper	Title of paper	Max. Marks			Minimum Marks			Total Marks T/P
		Theory	CCE	Practical	Theory	CCE	Practical	
I	In-Organic Chemistry	40	10	34	15	04	13	50 / 34.
II	Organic Chemistry	40	10	33	15	04	13	50 / 33
III	Physical Chemistry	40	10	33	15	04	13	50
IV	Group Theory & Spectroscopy I	40	10	-	15	04	-	50
V (a)	Mathematics for Chemists	40	10	-	15	04	-	50
V (b)	Biology for Chemists	40	10	-	15	04	-	50

Board of Studies :

I. Chairman - 

II. Subject Expert -

1. 

2. 

3. 

4.

5.

6.

7.

MSc –I Semester

Paper –I

INORGANIC CHEMISTRY

Marks - 50
Theory - 40
CCE - 10

Unit – I

Streochemistry and Bonding in Main Group Compounds :-

Introduction of Bonding theories in Covalent Molecules & Molecular orbital theory For hetroatomic Covalent molecules e.g.[CO, NO,CH₄]
VSEPR theory & its applications (Regular & Irregular geometry) with suitable examples.
Walsh diagram (triatomic molecule e.g. BeH₂, H₂O)
Bent Rule, $d\pi-p\pi$ bonding, some simple reaction in Covalent Molecules

Unit - II

Metal Ligand Equilibrium in Solution:-

Shapes and Geometry of complexes – Octahedral, tetrahedral and square planar complexes
Stepwise and overall formation constants and their interaction , trends in stepwise constant, factors affecting the stability of metal complexes with refrence to the nature of metal ion and ligand, Chelate effect and its application determination of Binary complexes. spectrophotometry method, Mole ratio method continous variation method,(Jobs Method)

Unit – III

Metal-Ligand bonding :-

Limitaion of crystal field theory , Molecular orbital theory for complexes, covalent bonding in metal ligand interaction, application of symmetry information of Molecular orbital, metal ligand sigma bonding with refrence to octahedral, Tetrahedral and square planar complexes, Stability of co-ordination compound and ligand field stabilization energy.

Unit – IV

Metal-Complexes :-

Ligand to metal π Bonding, and Metal to Ligand π Bonding and their effect on LFSE, structure and bonding of Metal carbonyl, structure elucidation of metal carbonyl using IR spectra (Peak position of CO frequency in different types of metal carbonyl compounds), classification of metal carbonyl preparation, sturcuture and important reaction of metal carbonyl e.g. [Ni(CO)₄], [Fe(CO)₅], [Cr(CO)₆]³⁺, [Mn₂(CO)₁₀]



Unit - V

HSAB Theory :-

Classification of acids and bases as hard and soft, HSAB principle, Theoretical basis of hardness and softness, Lewis acid-base reactivity approximation, Donor and acceptor numbers, E and C equation, application of HSAB concept.

Metallurgy Principle and different steps of metallurgy, Occurrence, isolation, purification, compounds and uses of following metals, Be, Th & U.

Books Suggested :-

1. Advanced Inorganic Chemistry F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry J.E. Huheey, Harpes & Row
3. Chemistry of the Elements N.N. Greenwood and A Earnshaw Pergamon.
4. Inorganic Electronic Spectroscopy A.B.P. Lever, Elsevier.
5. Magnetochemistry. R.I Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry eds.G.Wilkinson R.D. Gillars and J.A. Cleverty Pergamon.

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Chhindwara University, Chhindwara (M.P.)

Session :- 2020 – 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : Ist (प्रथम)

Paper - II

MCH-102 ORGANIC CHEMISTRY

Max. Marks / अधिकतमअंक : 40+10 CCE

Min. Marks/न्यूनतमअंक 15+04 CCE

UNIT I

Structure and bonding. Bonding in organic molecules. Delocalized chemical bonding- conjugation, cross conjugation, resonance, Hyperconjugation. Aromaticity in benzenoid and non-benzenoid compounds, alternate and non-alternate hydrocarbons. Huckel rule, anti-aromaticity, homoaromaticity. Bonds weaker than covalent bond. Hydrogen bonding, crown ether complexes, and cyclodextrins.

UNIT II

Stereochemistry. Chirality, elements of symmetry, molecules with more than one chiral center, threo and erythro isomers. R and S configuration. Separation of enantiomers. Regioselective. Stereospecific and stereoselective reactions. Asymmetric π synthesis. Optical activity in the absence of chiral carbon (atropisomerism)- biphenyls, allenes and spiranes, and their nomenclature.

UNIT III

Reaction Mechanism. Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, and control, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects, Effect of structure on reactivity, resonance and field effects, steric effect. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

UNIT IV

Aliphatic Nucleophilic Substitution. The SN₂, SN₁, mixed SN₂ and SN₁, and SET mechanisms. The S_Ni mechanism. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. The neighbouring group mechanism, neighbouring group participation by π and σ bonds. Classical and nonclassical carbocations, norbornyl system, carbocation rearrangements.

UNIT V





Conformational analysis of cyclohexanes and decalins. Effect of conformation on reactivity. Conformation of sugar.

The need for green chemistry, Ecoefficiency challenges. Pollution control & pollution provations green methods green products. Green Synthesis of paracetamol, green Synthesis of adipic acid, ibuprofen. Catachol, green chemistry andj their application in industrial process.

Books Suggested

1. Organic Chemistry, J. Claden, N. Greeves, S. Warren, P. Wothers, Oxford Universityj Press.
2. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, Wiley-Interscience.
3. Organic Chemistry, P.Y. Bruice. Pearson Education Asia.
4. Organic Chemistry. L. G. Wade, Jr. Pearson Education.
5. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.

6. Organic Chemistry, J. McMurry, Thomson Asia.
7. Organic Chemistry, T.W. G. Solomons and C.B. Fryhle. John Wiley (Asia).
8. A Guide Book to Mechanism in organic Chemistry, Peter Sykes, Longman.
9. Organic Chemistry, R.T. Morrison and R. N. Boyd, Prentice- Hall.
10. Stereochemistry of Organic Compounds, E.L. Eliel and S. H. and S.H.Wilen, John Wiley (Asia).
11. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
12. Stereochemistry of Organic Compounds, P. S. Kalsi, New Age International.
13. Introduction to Spectroscopy, D. L.Pavia, G.M. Lampman and G. S. Kriz, Thomson, Brooks, cole.
14. Organic Spectroscopy, W. Kemp, ELBS. Macmillan.
15. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley
16. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
17. Spectroscopic Methods in Organic Chemistry. D.H. Williams, I. Fleming. Tata McGraw-Hill.
18. Sangi A shirivastave Green Chemistry.

2020-2021

Class – m.sc

Semester - Ist

Subject -chemistry

Paper II - Organic Chemistry

UNIT I

Structure and bonding. Bonding in organic molecules. Delocalized chemical bonding- conjugation, cross conjugation, resonance, Hyperconjugation. Aromaticity in benzenoid and non-benzenoid compounds, alternate and non-alternate hydrocarbons. Huckel rule, anti-aromaticity, homoaromaticity. Bonds weaker than covalent bond. Hydrogen bonding, crown ether complexes, and cyclodextrins.

UNIT II

Stereochemistry. Chirality, elements of symmetry, molecules with more than one chiral center, threo and erythro isomers. R and S configuration. Separation of enantiomers. Regioselective. Stereospecific and stereoselective reactions. Asymmetric synthesis. Optical activity in the absence of chiral carbon (atropisomerism)- biphenyls, allenes and spiranes, and their nomenclature.

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UNIT IV

Aliphatic Nucleophilic Substitution. The SN2, SN1, mixed SN2 and SN1, and SET mechanisms. The SNi mechanism. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. The neighbouring group mechanism, neighbouring group participation by π and σ bonds. Classical and nonclassical carbocations, norbornyl system, carbocation rearrangements.

UNIT V

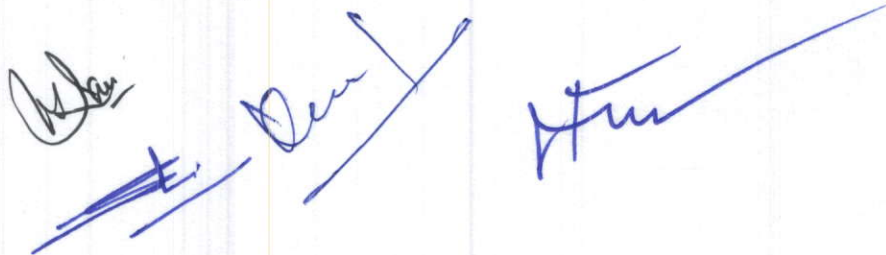
Conformational analysis of cyclohexanes and decalins. Effect of conformation on reactivity. Conformation of sugar.

The need for green chemistry, Ecoefficiency challenges. Pollution control & pollution prevention green methods green products. Green Synthesis of paracetamol, green Synthesis of adipic acid, ibuprofen. Catechol, green chemistry and their application in industrial process.



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1. Organic Chemistry, J. Claden, N. Greeves, S. Warren, P. Wothers, Oxford University Press.
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Chhindwara University, Chhindwara (M.P.)

Session :- 2020 - 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : 1st (प्रथम)

Paper - II

MCH-102 ORGANIC CHEMISTRY

Max. Marks / अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक 15+04 CCE

UNIT I

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The need for green chemistry, Ecoefficiency challenges. Pollution control & pollution prevention green methods green products. Green Synthesis of paracetamol, green Synthesis of adipic acid, ibuprofen. Catechol, green chemistry and their application in industrial process.



Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc.Chemistry

Semester/ सेमेस्टर: Ist(प्रथम)

Title of Subject / विषय का शीर्षक: Physical Chemistry I

Paper/प्रश्नपत्र : III (तृतीय)

Max. Marks/अधिकतमअंक: 40+10 CCE

Min. Marks/न्यूनतमअंक: 15+04 CCE

Unit I	Introduction to Exact Quantum Mechanical Results Schrodinger equation and the postulates of quantum mechanics. Discussion of solution of the Schrodinger equation to some model systems viz. particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom and helium atom.
Unit II	Approximate Methods The variation theorem, linear variation principle. Perturbation theory (First order and nondegenerate). Applications of variation method and perturbation theory to the Helium atom. Molecular Orbital Theory Huckel theory of conjugated systems bond and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical cyclobutadiene etc. Introduction to extended Huckel theory.
Unit III	Angular Momentum Ordinary angular momentum, generalized angular momentum, Eigen functions for angular Momentum, eigenvalues of angular momentum operator using ladder operators addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.
Unit IV	Classical Thermodynamics Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar free energy, partial molar volume and partial molar heat content and their significance. Determinations of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems : Excess functions for non-ideal solutions. Activity, activity coefficient, Debye Huckel theory for activity coefficient of electrolytic solution, determination of activity and activity coefficients; ionic strength. Appellation of phase rule to three component systems; second order phase transitions.
Unit V	Statistical Thermodynamics Concept of distribution, thermodynamic, probability and most probable distribution. Ensemble averaging, postulates of averaging. Canonical, grand canonical and micro canonical ensembles. Corresponding distribution laws (Using Lagrange's method of undetermined multipliers). Partition functions-translation, rotational, vibrational and electronic partition functions, Calculation of thermodynamic properties in terms of partition. Application of partition functions. Fermi-Dirac Statistics, distribution law and application to helium.



Chhindwara University, Chhindwara (M.P.)

Session :- 2020 - 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : I (प्रथम)

Paper - IV

MCH-104 Group Theory & Spectroscopy I

Max. Marks / अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक 15+04 CCE

UNIT-I

Symmetry elements and symmetry operation, Definition of group, subgroup, Conjugacy reaction and classes, point symmetry group. Schoenflies symbols. Point symmetry group Schoenflies symbols. Representations of groups by matrices (representation for the C_n , C_{nv} , C_{nh} , D_{nh} group to be worked out explicitly) Character of a representation, The great orthogonality theorem (without proof) and its importance. Character tables and their use. Spectroscopy. Derivation of character table for C_{2v} and C_{3v} point group Symmetry aspects of molecular vibrations of H_2O molecule.

UNIT-II

Microwave Spectroscopy - Classification of molecules, Rigid rotor model, Effect of isotopic substitution of the transition of the transition frequencies, Effect of isotopic substitution of the transition frequencies, Intensities, non-rigid rotor, Stark effect, Nuclear and electron spin interaction and effect of external field applications.

UNIT-III

Infrared Spectroscopy - Review of Linear harmonic oscillator, Vibrational energies of diatomic molecules, Zero point energy, force constant and bond strengths, Anharmonicity, Morse potential energy diagram, Vibration rotation spectroscopy P. Q. R. branches Breakdown of Oppenheimer approximation. Vibrations of polyatomic molecules Selection rules normal modes of vibration. Group frequencies, overtones hot bands, Factors affecting the band position and intensities far IR region Metal ligand vibration, normal co-ordinate analysis.

UNIT-IV

Raman Spectroscopy- Classical and quantum theories of Raman effect, Pure, rotational, vibrational and vibrational rotational Raman spectra. Selection rules, Mutual exclusion principle, Resonance, Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS)

UNIT-V

Electronic Spectroscopy- Energy levels molecular orbitals. Vibronic transitions, Vibration progression and geometry of the excited states, Franck-Condon principle, Electronic spectra of polyatomic molecules, Emission spectra radioactive and non radioactive decay internal conversion. Spectra of transition metal complexes, Charge transfer spectra.

Photoelectron Spectroscopy- Basic principle, Photo-electric effect, Ionization process Koopman's theorem Photoelectron spectra of simple molecules, ESCA chemical information from ESCA Auger electron spectroscopy basic idea.

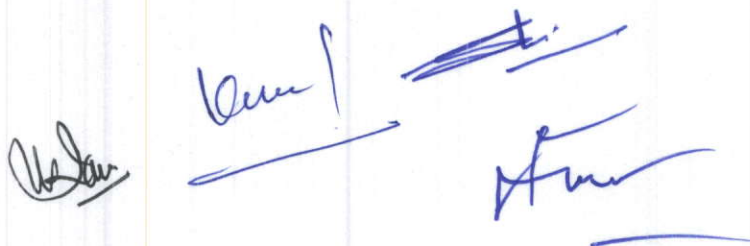
Characterization & synthesis of nanoparticle

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Introduction, importance & Characterization of Nano materials, Stability of nano material in solutions.

Books Suggested

1. Modern Spectroscopy, J.M. Hollas. John Wiley.
2. Applied Electron Spectroscopy for chemical analysis d.H. Windawi and F.L. Ho wiley **Interscience.**
3. NMR. NQR EPr and Mossbauer Spectroscopy in Inorganic Chemistry R. V. parish, Ellis Harwood.
4. Physical Methods in Chemistry R.S. Drago. Saunders Collage.
5. Chemical Applications Group Theory F.A. Cotton.
6. Tntroduction to molecular Spectrocopy G.M. Barrow Mc Graw Hill.
7. Basic Principles of Spectroscopy. R. Chang, Mc Graw Hill.
8. Theory and Application of UV Spectroscopy H.H. Jaffe and M. Orehin IBH Oxford.
9. Introduction to Photoelectron Spectroscopy P.K. Ghosh, John Wiley.
10. Introduction to Mgentic Resonance. A Carrington and A.D. Machachalan, Harper & Row.



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Chhindwara University, Chhindwara (M.P.)

Session :- 2020 - 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : 1st (प्रथम)

Paper-V

MCH-405 (a): MATHEMATICS FOR CHEMISTS
(For Students without Mathematics in B.sc)

Max. Marks / अधिकतमअंक : 40+10 CCE

Min. Marks/न्यूनतमअंक 15+04CCE

OBJECTIVE - To understand the basic concept of vectors & differential calculus.

Unit -1

Vectors

- Vectors, dot, cross and triple products etc, gradient.
- Divergence and curl, Vector Calculus.

Matrix Algebra

- Addition and multiplication.
- Inverse adjoint and transpose of matrices.

Unit - II

Differential Calculus :

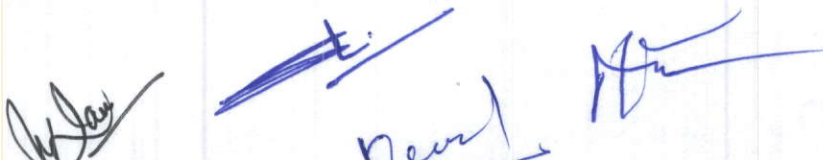
- Functions, continuity and differentiability.
- Rules for differentiation of differential calculus in eluding maxima and minima (examples related to maximally populated rotational energy levels.
- Bohr's radius and most probable velocity from Maxwell's distribution etc).

Unit-III

Integral calculus:

Basic rules for integration.

- Integration by parts, parts, partial fractions and substitution.
- Reduction formulae,
- Applications of several variables.
- Functions of several variables.
- Partial differentiation.
- Co-or dinat transformations (e.g. Cartesian to spherical polar)



Chhindwara University, Chhindwara (M.P.)

Session :- 2020 - 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : Ist (प्रथम)

Paper -V

MCH-405 (b): BOLOGY FOR CHEMISTS

(For students without Mathematics in B.Sc)

Max. Marks / अधिकतमअंक : 40+10 CCE

Min. Marks/न्यूनतमअंक 15+04CCE

OBJECTIVE – to understand the basic concept cell structure and Functions Lipid.

Unit – I

Cell Structure and Functions

- Structure prokaryotic and eukaryotic cells.
- Intracellular organelles and their functions.
- Comparison of plant and animal cells.
- Overview and their functions.
- Comparison of plant and animal cells.
- Overview of metabolic processes- catabolism and anabolism.
- ATP- the biological energy currency.
- Origin of life-unique properties of carbon chemical evolution and rise of living systems. Introduction to bio-molecules.
- Building blocks of bio macromolecules.

Unit – II

Carbohydrates:

- Conformation fo monosaccharides.
- Structure and functions of important derivatives of mono- saccharedes like glycosides.
- Deoxy sugars.
- Myoinositol, amino sugars.
- N – acetylmuramic acid, sialic acid disaccharides and polysaccharides.
- Storage polysaccharides cellulose and chitin.
- Structure and biological function of glucosaminoglyeams of mucopolysaccharides .
- Carbohydrates of glycoprotein's and glycolipids.
- Role of sugras in biological recognition.
- Blood group substances. Ascorbic acid.



- Biochemistry J. David Rawan, Neil Patterson.
- Outlines of Biochemistry E.E. conn and P.K. stumpf. Johh wiley.

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A smaller signature above it, possibly "Neil".
A signature on the right, possibly "E.E. Conn", with a horizontal stroke below it.
A signature below that, possibly "P.K. Stumpf", with a horizontal stroke below it.

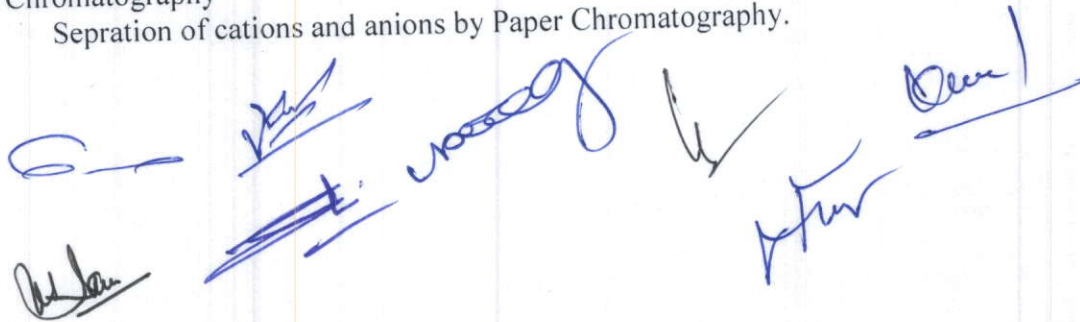
INORGANIC CHEMISTRY

Practical-Chemistry M.Sc. Semester- I

Qualitative and analysis	-	8
Chromatography	-	8
Estimation	-	8
Record	-	5
Viva-Voce	-	5

Marks - 34

- 1- Qualitative ~~and~~ analysis - 7 radical analysis 3 acidic and 3 basic and 1 interfering.
- Less common metal ions : Ti, Mo, W, Xr, (two metal ions in cationic/anionic forms)
- 2- Insoluble-Oxides, sulphates and halides.
Estimation of two metal ions Cu-Ni, Ni-Zn-Fe ~~etc.~~ CU
- 3- Chromatography
Separation of cations and anions by Paper Chromatography.



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Practical

MS.c. Semester – I

Duration – 6-8 hours in each branch

Physical Chemistry

Max Marks - 33

Physical Chemistry	8
Error Analysis and Statistical Data Analysis	8
Chemical Kinetics	8
Solution	4
Record	5
Viva Voce	

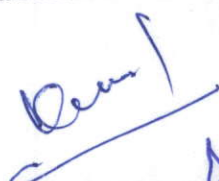
Error Analysis and Statistical Data Analysis – Theoretical Knowledge of

Error, Types of errors, minimization of errors distribution curves precision, accuracy and combination; statistical treatment for error analysis, student test, null hypothesis, rejection criteria. F & Q test. Adsorption To study surface tension- concentration relationship for solution (Gibbs equation), Phase Equilibria .

- 1- Calibration of weights, volumetric apparatus & instruments, burette, piette standard flask,
- 2- Determination of congruent composition and temperature of a binary system (e.g diphenylamine-benzophenone system).
- 3- Determination of a glass transition temperature of given salt (e.g. CaCl_2) conductometrically.
- 4- To construct the phase diagram for three component system (e.g. chloroform-acetic acid- water)
- 5- Study of surface tension, concentration, relationship for solution (Gibbs equation)

Chemical Kinetics-

- 1- Determination of the effect of
 - (a) change of temperature
 - (b) change of concentration of reactant and catalyst
 - (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction.
- 2- Determination of the velocity constant of hydrolysis of and ester/ionic reaction in micellar media.
- 3- Determination of the velocity constant for the oxidation of iodide ions by hydrogen peroxide study the kinetics as an iodine clock reaction.
- 4- Flowing clock reactions.



Practical

MS.c. Semester – I

Duration – 6-8 hours in each branch

Organic Chemistry

Max Marks - 33

Organic Chemistry

Qualitative Analysis (8+4)

- Separation purification and identification of compounds of Binary mixture (one) (8)
- Liquid and one solid using TLC and columns chromatography.
- Chemical tests.

- IR spectra to be used for functional group identification and interpretation of saturated and unsaturated hydrocarbon alcohols and phenols. (4)

Analysis

- Analysis estimation of Sulphur by messenger method. (4)

Synthesis

- Acetylation : Acetylation of cholesterol and separation of cholesteryls acetate by column chromatography. (4)
- Oxidation : Adipic acid by chromic acid oxidation of cyclohexanol
- Grignard reaction : Synthesis of triphenyl methanol from benzoic acid The Products may be Characterized by Spectral Techniques.
- Electrophilic Substitution including nitration bromination of diazotization.
- Dehydration of carboxylic compounds .

Determination

- Determination of Equivalent weight of carboxylic acid by titration method. (4)
1. Grammar : Conditionals /Tenses, relative clauses, subject – verb agreement, passive voice
 2. Written Communication: Discuss a topic of general interest, but related to science in about 300 words. (Analyze, comment, argue, reflect, persuade etc.)
(can also be used for oral presentations by the students, followed by discussion).
 3. Oral Communication : (1) Consulting a dictionary for correct pronunciation (familiarity with phonetics symbols and stress-marks only) (2) Dialogue.

Record- 4

Viva- 5

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Chhindwara University, Chhindwara (M.P.)

SYLLABUS OF ~~M.A./M.Com./M.Sc./M.H.Sc. PREVIOUS/SERIAL~~ OR SEMESTER

II Chemistry

Name of Paper	Title of paper	Max. Marks			Minimum Marks			Total Theory/Practical
		Theory	CCE	Practical	Theory	CCE	Practical	
I	In. Organic Chemistry	40	10	34	15	04	13	50/34
II	Organic Chemistry	40	10	33	15	04	13	50/33
III	Physical Chemistry	40	10	33	15	04	13	50/33
IV	Spectroscopy & Diffraction ^{II} infrared	40	10	-	15	04	-	50
V	Computer for Chemist.	40	10	-	15	04	-	50

Board of Studies :

- I. Chairman - 
- II. Subject Expert -

1. 
2. 
3. 
- 4.
- 5.
- 6.
- 7.

MSc -II Semester
Paper -I
INORGANIC CHEMISTRY

Marks-50
Theory -40
CCE -10

Unit - I

Reaction mechanism in Transition Metal Complexes -
Energy profile of a reaction, Reactivity of metal complex, inert and labile complexes, Kinetic application of valence bond and crystal field theories kinetics of octahedral substitution, Acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis conjugate base mechanism, Direct and indirect evidence in favour of conjugate mechanism, Anation reaction.

Unit - II

Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction in octahedral and square planar complexes. Redox reaction, Electron transfer reactions, Mechanism of one electron transfer reactions, Outer and inner sphere type reactions, Cross reactions and Marcus Hush Theor.

Unit - III

Organometallic Compound : Definition, Preparation method, 18 electron rule with suitable examples, types of Organometallic compounds, reaction mechanism in Organometallic compounds (Oxidative addition, reductive elimination, C-H activation, β elimination activation insertion reaction etc) Higher boranes (structure of closo, nido, and arachno boranes).

Unit - IV

Electronic Spectral Studies of Transition Metal Complexes : Introduction of total spin quantum no, total angular momentum quantum no L-S coupling (Russel-saunders coupling) and Spectroscopic ground states. Correlation diagram for d^2 system Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9 states). Selection rule for electronic spectroscopy and their relaxation Intensity of various types electronic transitions of $10Dq$, B and β parameters, charge transfer spectra.

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Unit - V

Magnetic Properties of Transition Metal Complexes, Magnetic susceptibility, g-value
Anomalous magnetic moments. Quenching of Orbital contribution. Orbital contribution to
magnetic moment, magnetic exchange coupling and spin crossover, application of magnetic
properties

Books Suggested :

1. Advanced Inorganic Chemistry F.A.Cotton and Wilkinson, John Wiley
2. Inorganic Chemistry J.E. Huhey. Harpes & Row.
3. Chemistry of the Elements N.N.Greenwood and A Earnshaw, Pergamen
4. Inorganic Electronic Spectroscopy A.B.P.Lever Elsevier.
5. Magnetiocnhemistry R.I.Carlin Springer Verlag
6. Comperhensive Coordination chemistry eds. G. Wilknson R.D.Gillars J.A
7. Principle in Inorganic Chemistry, Puri Sharma, and Kaliya
8. Inorganic Chemistry Donald, Tarr, Garry, Miessler
9. Organometallic chemistry : Ajay Kumar
10. Co-ordination Chemistry : D. Banerjee



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Chhindwara University, Chhindwara (M.P.)

Session :- 2020 – 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : II (द्वितीय)

Paper - II

MCH-102 ORGANIC CHEMISTRY

Max. Marks / अधिकतमअंक : 40+10 CCE

Min. Marks/न्यूनतमअंक 15+04CCE

UNIT - I

Aromatic Electrophilic Substitution

The arenium ion mechanism, Orientation and reactivity, Energy profile diagrams, The ortho/para ratio, Ipso attack, Orientation in ring systems, Quantitative treatment of reactivity in substrates and electrophiles, Diazonium coupling, Vilsmeier reaction, Gatterman-Koch reaction.

Aromatic Nucleophilic Substitution- The S_NAr S_N1, Benzyne and S_N1 mechanism, Reactivity effect of substrate structure, leaving group and attacking nucleophile, The Von Richter, Sommelet-Hauser, and Smiles rearrangements.

UNIT-II

Free Radical Reactions – Types of free radical reactions, Free radical substitution mechanism, Mechanism at an aromatic substrate, neighbouring group assistance, Reactivity for aliphatic aromatic substrates at a bridgehead, Reactivity in the attacking radicals, The effect of solvents on reactivity, Allylic halogenation(NBS), Oxidation of aldehydes to carboxylic acids, Auto-oxidation, Coupling of alkynes and arylation of aromatic compounds diazonium salts, Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction.

UNIT-III

Addition Reactions – Mechanistic and stereochemical aspects of addition reactions involving electrophiles, Nucleophiles and free radicals, Regio-and chemoselectivity, Orientation and reactivity, Addition to cyclopropane ring, Hydrogenation of double and triple bonds, Hydroboration, Hydrogenation of aromatic rings, Michael reaction, Sharpless asymmetric epoxidation.

UNIT-IV

Addition to Carbon-Hetero Multiple bonds – Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, Acid esters and nitriles, Addition of Grignard reagents, Organozinc and Organolithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction, Mechanism of condensation reactions involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions, Hydrolysis of esters and amides ammonolysis of esters.

Elimination Reactions- The E₂, E₁ and E_{1c}B mechanisms and their spectrum, Orientation of the double bond, Reactivity- effects of substrate structures, attacking base the leaving group and the medium, Mechanism and orientation in pyrolytic elimination.



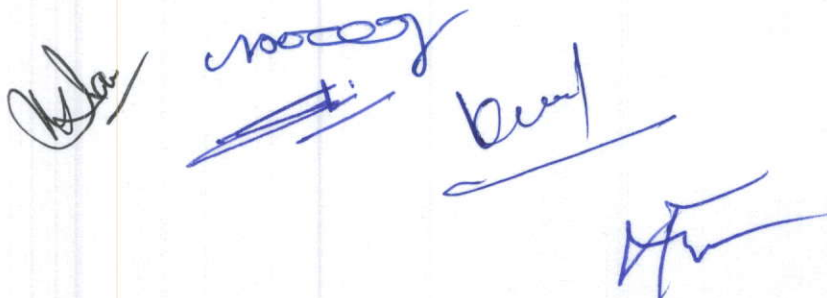
UNIT-V

Pericyclic Reactions –Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5 hexatriene and allyl system,, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams, FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, $4n$ $4n+2$ and allyl systems, Cycloadditions-antarafacial and suprafacial additions, $4n$ and $4n+2$ systems, $2+2$ addition of ketenes, 1,3 dipolar cycloadditions and cheletropic reactions, Sigmatropic rearrangements-suprafacial and antarafacial shifts of H, sigmatropic involving carbon moieties, 3,3 and 5,5 sigmatropic rearrangements, Claisen, Cope and aza-Cope rearrangements, Fluxional tautomerism, Ene reaction.

Green Chemistry- Twelve principle of green chemistry, Awards of green chemistry international organizations, promoting green chemistry, Recycling of waste.

Books suggested

- 1 Advanced organic Chemistry- Reactions, Mechanism and Structure, Jerry March, John Wiley.
- 2 A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
- 3 Organic Chemistry, R.T. Morrison and R. N. Boyd, Prentice-Hall.
- 4 Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S. P. Singh, Macmillan.
- 5 Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
- 6 Stereochemistry of Organic Compounds, E.L. Eliel and S. H. and S.H. Wilen, John Wiley (Asia).
- 7 Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.

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Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc.Chemistry

Semester/ सेमेस्टर: II (द्वितीय)

Title of Subject / विषय का शीर्षक: Physical Chemistry II

Paper/प्रश्नपत्र : III

Max. Marks/अधिकतमअंक:40+10 CCE

Min. Marks/न्यूनतमअंक: 15+04 CCE

Unit I	Chemical Dynamics Methods of determining 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 state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical-(hydrogen-bromine and hydrogen-chlorine reactions) and homogenous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method, dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus (RRKM) theories for unimolecular reactions).
Unit II	Surface Chemistry Adsorption Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), Surface films on liquids (Electro-kinetic phenomenon). Micelles Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and: mass action models, solubilization, micro emulsion, reverse micelles.
Unit III	Macromolecules Polymer-definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (Ostometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, of average dimension of average determination.
Unit IV	entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction.

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Unit V

Electrochemistry

Electrochemistry of solutions. Debye-Huckel-Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerum mode. Thermodynamic's of electrified interface equations. Derivation of electro capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. Overpotentials, exchange current density, derivation of Butler Volmer equation, Tafel plot. Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling. Semiconductor interfaces-theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface. Polarography theory, Ilkovic equation; half wave potential and its significance.

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Chhindwara University, Chhindwara (M.P.)

Session :- 2020 – 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : II (द्वितीय)

Paper – IV

MCH-204 SPECTROSCOPY AND DIFFRACTION METHOD II

Max. Marks / अधिकतमअंक : 40+10 CCE

Min. Marks/न्यूनतमअंक 15+04 CCE

UNIT-I

Nuclear Magnetic Resonance Spectroscopy

Nuclear spin, Nuclear resonance, Saturation, Shielding of magnetic nuclei, Chemical shift and its measurements, factors, influencing chemical shift, Deshielding, spin-spin interactions, Factors influencing coupling constant "J" Classification (AXB, AMX, ABC, A2B2 etc), Spin decoupling, Basic ideas about instrument, NMR studies of nuclei other than proton- ^{13}C , ^{19}F and ^{31}P . FT NMR, advantages of FT NMR.

UNIT-II

Nuclear quadrupole Resonance Spectroscopy – Quadrupole nuclei, Quadrupole moments, Electric field gradient, Coupling constant, Splitting, Applications.

UNIT-III

Electron Spin Resonance Spectroscopy- Basic principles, Zero field splitting, Kramer's degeneracy, Factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, Spin densities, Mc Connell relationship, Measurement techniques, Applications.

UNIT-IV

X-ray Diffraction

Bragg condition, Miller indices, Laue Method, Bragg method, Debye Scherrer method of x-ray structural analysis of crystals, Index reflections, Identification of unit cells from systematic absences in diffraction pattern, Structure of simple lattices and X-ray intensities, Structure factor and its relation to intensity and electron density, Phase problem, Description of the procedure for an X-ray structure analysis, Absolute configuration of molecules.

UNIT-V

Electron Diffraction- Scattering intensity vs. scattering angle, Wierl equation, Measurement technique, Elucidation of structure of simple gas phase molecules, Low energy electron electron diffraction and structure of surfaces, Neutron Diffraction Scattering of neutrons by solids measurement techniques, Elucidation of structure of magnetically ordered unit cells.

SYNTHESIS OF NANO MATERIALS

Physical method- laser ablation evaporation sputtering & solvated metal dispersion.

Chhindwara University, Chhindwara (M.P.)

Session :- 2020 – 21

Class / कक्षा : M.Sc. Chemistry

Semester / सेमेस्टर : II (द्वितीय)

Paper – V

MCH-205 COMPUTER FOR CHEMISTS

Max. Marks / अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक 15+04 CCE

UNIT-I

Introduction to computers and Computing – Basic structure and functioning of computer with a PC as illustrative example, Memory I/o devices, Secondary storage Computer languages, Operating systems with DOS as an example Introduction to UNIX and WINDOWS, Principles of programming Algorithms and flow-charts.

UNIT-II

Computer Programming in FORTRAN/C/BASIC – The language features are listed here with reference to FORTRAN, The instructor may choose another language such as BASIC or the features may be replaced appropriately) Elements of the compute language. Constants and variables Operations and symbols Expressions, Arithmetic assignment statement Input and output Format statement. Termination statements. Branching statements as IF or GO TO statements, LOGICAL variables and DIMENSION, DO statement FUNCTION statement (Student learn the programming logic and these language feagy hands on experience on on a personal computer form the beginning of this topic.

UNIT-III

- 1 Developing of small computer codes using any one of the languages FORTRAN/C/BASIC involving simple formulae in Chemistry, such as Van der Waals equation
- 2 Chemical kinetics (determination of Rate constant) Radioactive decay (Half Life and Average Life)
- 3 Molarity and Molality of solutions.
- 4 Evaluation of electronegativity of atom and Lattice Energy from experimental determination of molecular weight and percentage of element organic compounds using data from experiments metal representation of molecules in terms of elementary structural features such as bond angles.

UNIT-IV

Use of Computer programs- Operation of PC, Data Processing, Running of standard and Packages such as MS WORD, MS EXCEL -special emphasis on calculations and chart formations. X-Y plot Simpson's Numerical Intergration method. Programmes with data preferably from physical chemistry laboratory

UNIT-V

Internet- Application of Internet for Chemistry with search engines. Various types of file like PDF, JPG RTF and Bitmap, Scanning OMR, Web camera

Books Suggested :- Fundamentals of computer V Rajaraman (Prentice Hall) Comistry. K.V. Raman (TATA Mc Graw Hill) Computer Programming in FORTRAN IV-V Rajaramen (Prentice Hall)

Practical

MS.c. Semester – II

Duration – 6-8 hours in each branch

Physical Chemistry

Max Marks - 33

Physical Chemistry	
Conductometry	8
Potentiometry/pH metry	8
Polarimetry	8
Record	4
Viva Voce	5

Conductometry

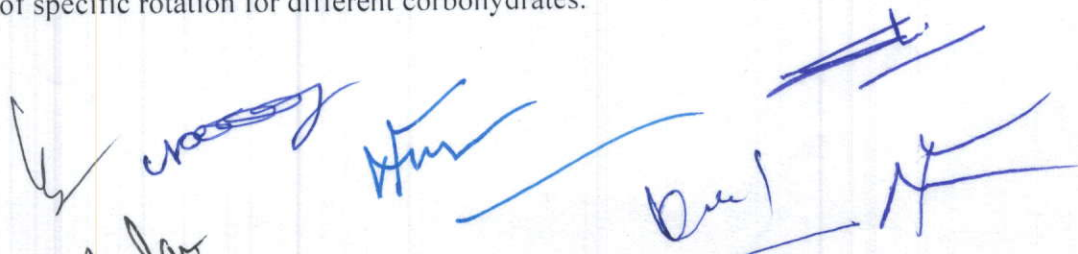
- i- Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
- ii- Determination of solubility and solubility product of sparingly soluble salts (e.g. PbSO_4) Conductometrically.
- iii- Determination of strength of strong and weak acid in a given mixture conductometrically.
- iv- To study of the effect of solvent on the conductance of AgNO_3 /acetic acid and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye- Huckel- Onsager theory.
- v- Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye- Huckel's limiting law.

Potentiometry/pH metry

- 1- Determination of strengths of halides in a mixture potentiometrically.
- 2- Determination of the velocity of mercurous ions potentionmetrically.
- 3- Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
- 4- Determination of temperature dependence of EMF of a cell.
- 5- Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.

Polarimetry

- 1- Determination of Rate constant for hydrolysis inversion cane suger using of polarimeter.
- 2- Determination of specific rotation for different corbohydrates.



Chemical method -Thermolysis sonochemical approach, reduction of metal ions by hydrogen & methanol.

Books suggested

1. Modern Spectroscopy, J.M. Hollas. John Wiley.
2. Applied Electron Spectroscopy Spectroscopy for chemical analysis d. H. Windway and F.L.Ho, Wiley.
3. Chemical application of Group Theory, F.A. Cotton.
4. Introduction to Molecular Spectroscopy G.M. Barrow Mc Graw Hill.
5. Basic Principal of Spectroscopy, R. Chang, Mc Graw Hill.
6. Theory and application and of U.V. Spectroscopy H.H. Jaffe and M. Orchin, IBH-Oxford.
7. Introduction to Photoelectron to Photoelectron Spectroscopy P.K. Ghosh, John Wiley.
8. Introduction to Magnetic Resonance. A Carrington and A. D. MacLachalan, harper & Row. +



Chhindwara University, Chhindwara (M.P.)

Session :- 2020 – 21

Practical

Class / कक्षा : M.Sc. II Chemistry

Semester / सेमेस्टर : II (द्वितीय)

Duration – 6-8 hours in each branch
ORGANIC CHEMISTRY

Max Marks - 33

Qualitative Analysis

Separation, Purification and identification of Binary / Ternary mixture.

(6)

Organic Synthesis

- Aldol condensation Dibenzal acetone from benzaldehyde. (6)
- Sandmeyer reaction : p-Chlorotoluene from p-toluidine.
- Acetoacetic ester Condensation : Synthesis of ethyl-n- butylacetoacetate by A.E.E. condensation: b- Benzoyl propionic acid from succinic anhydride and benzene.
- Aromatic electrophilic substitutions : Synthesis of p- nitro aniline and p- bromoaniline.

- The Products may be Characterized by Spectral Techniques. Interpretation of saturated and unsaturated hydrocarbons, Alcohol Phenol, Ether, Carbonyl Compounds. (6)

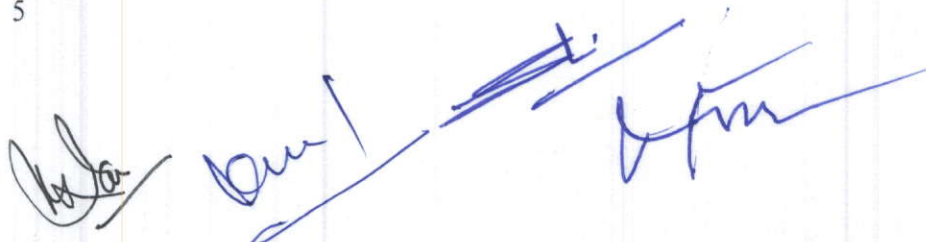
Qualitative Synthesis

- Determination of the percentage or number of hydroxyl groups in organic Compound by acetylation method. (6)
- Estimation of amines/phenols using brominated bromide solution/or acetylation method.
- Determination of iodine and Saponification values of and oil sample.
- Determination of DO.COD and BOD of Water sample.
- Estimation of commercial glucose solution.

Communication Skills:

1. Scientific writing: Writing a Scientific Report on a project undertaken or an experiment conducted (theory + practical)
2. Gestures / postures – Body language, gesture, posture.
3. Group discussion – Giving up of PREP, REP Technique, how body language during group discussion.

Viva- 4
Record- 5



INORGANIC CHEMISTRY

Practical-Chemistry MS.c Semester- II

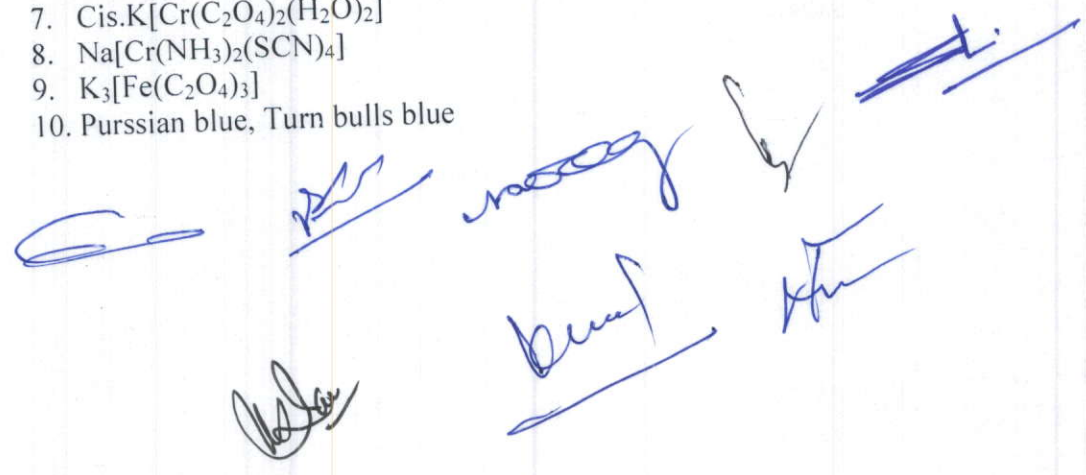
Water Analysis	-	12
Preparation	-	12
Record	-	05
Viva-Voce	-	05

Marks - 34

1. Water Analysis
Ca-hardness (EDTA method), alkalinity, chemical oxygen demand.
2. Preparation

Preparation of selected inorganic compounds and their studies by I.R. electronic spectra. Mossbauer, E.S.R. and magnetic susceptibility measurements, Handling of air and moisture sensitive compounds.

1. $[\text{Co}(\text{NH}_3)_6][\text{Co}(\text{NO}_2)_6]$
2. $[\text{Co}(\text{Py})_2\text{Cl}]_2$
3. $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
4. $[\text{Ni}(\text{dmg})_2]$
5. $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4\cdot\text{H}_2\text{O}$
6. $\text{VO}(\text{acac})_2$
7. $\text{Cis.K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]$
8. $\text{Na}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$
9. $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
10. Prussian blue, Turn bulls blue



Chhindwara University, Chhindwara (M.P.)

III

SYLLABUS OF M.A./M.Com./M.Sc./M.H.Sc. PREVIOUS/FINAL OR SEMESTER

Name of Paper	Title of paper	Max. Marks			Minimum Marks			Total Marks
		Theory	CCE	Practical	Theory	CCE	Practical	
I	Application of Spectroscopy I	40	10		15	04		50
II	Photo Chemistry	40	10		15	04		50
III	Environmental Chemistry	40	10		15	04		50
IV and V optional	Group A. Chemistry of Macerals	40	10		15	04		50
	2. Heterocyclic Chemistry	40	10		15	04		50
	3. Physical Organic Chemistry	40	10		15	04		50

Group B.
 1. Polymer Chemistry
 2. Heavy Chemical and Petrolium.

- Board of Studies :
- I. Chairman *[Signature]*
 - II. Subject Expert -
 3. Organic transition metal chemistry

1. *[Signature]*
2. *[Signature]*
3. *[Signature]*
4. *[Signature]*

Practical - Max. Marks

In-Organic	34	13
Organic	33	13
Physical	33	13

Chhindwara University, Chhindwara(MP)
Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

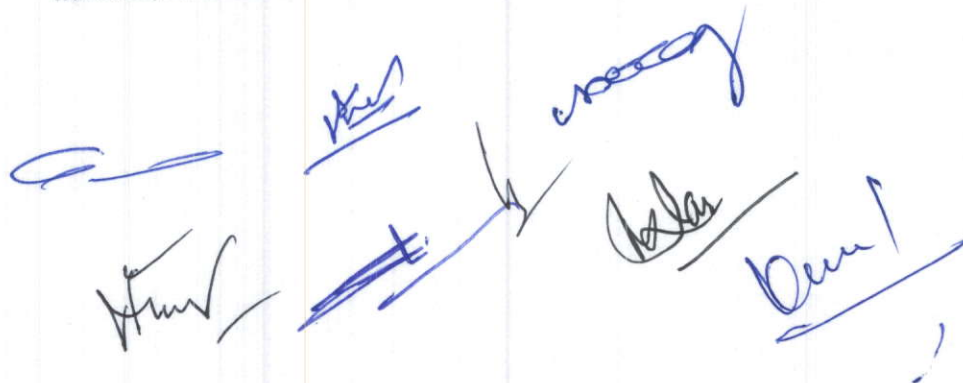
Title of Subject / विषय का शीर्षक : Application of Spectroscopy – I

Paper/प्रश्न पत्र : I

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

- Unit I **Electronic Spectroscopy :**
Electronic Spectral Studies for $d^1 - d^9$ systems in octahedral, tetrahedral and square planer complexes.
- Unit II **Vibrational Spectroscopy**
Symmetry and shapes of AB_2, AB_3, AB_4, AB_5 and AB_6 , mode of bonding of ambidentate ligands, nitrosyl, ethylenediamine and diketontao complexes, application of resonance Raman spectroscopy and its applications.
- Unit III **Nuclear Magnetic Resonance Spectroscopy – I**
General introduction and definition, chemical shift, spin-spin interaction, shielding and deshielding mechanism, mechanism of measurement of chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & marcapton),
- Unit IV **Nuclear Magnetic Resonance Spectroscopy – II**
Chemical exchange, effect of deuteration, Complex spin spin interaction between two, three four and five nuelei (I order spectra) Stereochemistry, hindered rotation, Karplus vurve-variation of coupling constant with disordered angle. NMR shift reagents, solvent effects. Nuclear overhauser effect (NOE).
- Unit V **Mossbauer Spectroscopy** Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds nature of M-L bond, co-ordination number, structure and (3) detection of oxidation state and in equivalent MB atoms.



Chhindwara University, Chhindwara(MP)
Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Photochemistry

Paper/प्रश्न पत्र : II

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

- Unit I **Photochemical Reaction**
Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.
- Unit II **Determination of Reaction Mechanism**
Classification, rate constants and life times of reactive energy state, determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions-photo dissociations, gas-phase photolysis.
- Unit III **Photochemistry of Alkenes**
Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4-and 1,5-dienes.
Photochemistry of Aromatic Compounds
Isomerisation, additions and substitutions.
- Unit IV **Photochemistry of Carbonyl Compounds**
Intramolecular reactions of carbonyl compounds-saturated, cyclic and acyclic, β , γ unsaturated and α , β unsaturated compounds, cyclohexadienones. Intermolecular cycloaddition reactions-dimerisations and oxetane formation.
- Unit V **Miscellaneous Photochemical Reactions**
Photo-Fries reactions of annilides, Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen and its reactions. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.



Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Environmental Chemistry

Paper/प्रश्न पत्र : III

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

Particulars/विवरण

Unit I

Atmosphere

Atmospheric layers, Vertical temperature profile, heat/radiation budget of the earth atmosphere systems. Properties of troposphere, thermodynamic derivation of lapse rate. Temperature Inversion. Calculation of Global mean temperature of the atmosphere. Biogeochemical cycles of carbon, nitrogen, sulphur, phosphorus, oxygen. Residence times.

Atmospheric Chemistry

Sources of trace atmospheric constituents : nitrogen oxides, Sulphur dioxide and other sulphur compounds, carbon oxides, chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons.

Tropospheric Photochemistry

Mechanism Photochemical decomposition of NO₂ and formation of ozone. Formation of oxygen atoms, hydroxyl, hydro peroxy and organic radicals and hydrogen peroxide. Reactions of hydroxyl radicals with methane and other organic compounds. Reaction of OH radicals with SO₂ and NO₂. Formation of Nitrate radical and its reactions. Photochemical smog meteorological conditions and chemistry of its formation.

Unit II

Air Pollution

Air pollutants and their classifications. Aerosols-sources, size distribution and effect on visibility, climate and health.

Acid Rain

Definition, Acid rain precursors and their aqueous and gas phase atmospheric oxidation reactions. Damaging effects on aquatic life, plants, buildings-and health. Monitoring of SO₂ and NO₂. Acid rain control strategies

Mechanism of Ozone formation, Mechanism of catalytic ozone depletion, Discovery of Antarctic Ozone hole and Role of chemistry and meteorology. Control Strategies.

Green House Effect

Terrestrial and solar radiation Spectra, Major green house gases and their sources and Global warming potentials. Climate change and consequences.

Urban Air Pollution

Exhaust emissions, damaging effects of carbon monoxide. Monitoring of CO. Control strategies.

Unit III

Aquatic Chemistry and Water Pollution

Redox chemistry in natural waters. Dissolved oxygen, biological, oxygen demand, chemical oxygen demand, determination of DO, BOD and COD. Aerobic and anaerobic reactions of organic sulphur and nitrogen compounds in water acid-base chemistry of fresh water and sea water. Aluminum, nitrate and fluoride in water. Petrification. Sources of water pollution. Treatment of waste and sewage. Purification of drinking water, techniques of purification and disinfection.

Chhindwara University, Chhindwara(MP)

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Unit IV

Environmental Toxicology

Toxic heavy metals: Mercury, lead, arsenic and cadmium. Causes of toxicity. Bioaccumulation, sources of heavy metals. Chemical speciation of Hg, Pb, As, and Cd. Biochemical and damaging effects.

Toxic Organic Compound : Pesticides, classification, properties and uses of organochlorine and ionospheres pesticides detection and damaging effects.

Polychlorinated biphenyls : Properties, use and environmental continuation and effects.

Polynuclear Aromatic Hydrocarbons : Source, structures and as pollutants.

Unit V

Soil and Environmental Disasters ' Soil composition, micro and niacrernutrient, soil pollution by fertilizers, plastic an metals. Methods of re-mediation of soil. Bhopal gas tragedy, Chernobyl, three mile island, Minimtata Disease, Sevoso (Italy), London smog.



Chhindwara University, Chhindwara(MP)
Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Chemistry of Materials

Paper/प्रश्न पत्र : IV OPT-1

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

Particulars/विवरण

Unit I

A. Multiphase materials

Ferrous alloys; Fe-C phase transformations in ferrous alloys; stainless steels, non ferrous alloys, properties of ferrous and non-ferrous alloys and their applications.

B. Glasses, Ceramics, Composites and Nanomaterials

Glassy state, glass formers and glass modifiers, applications. Ceramiiic structures, mechanical properties, clay products. Refractories, characterizations, properties and applications.

Microscopic composites; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties, applications.

Unit II

A. Thin Films and Langmuir-Blodgett Films

Preparation techniques; evaporation/sputtering, chemical processes, MOCVD, sol-gel etc. Languir-Blodgett (LB) film, growth techniques, photolithography, properties and applications of thin and LB films.

B. Liquid Crystals

Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic-nematic transition and clearing temperature -homeotropic, planer and schlieren textures, twisted nematics, chiral nematics, le r arrangement in smectic A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

Unit III

A. Polymeric Materials

Molecuar shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behavior, polymer types and their application, conductiong and ferro- electric polymers.

B. Ionic Conductors

Types of ionic conductgors, mechanism of ionic conduction, interstitial jumps (Frenkil); vacancy mechanism, diffusion superionic conductors; phase transitions and mechanism of 'conduction in superionic conductors, examples and applications of ionic conductors.

Unit IV

High Tc Materials

Defect perovskites, high Tc superconductivity in cuprates, preparation and characterization of-1-2-3 and 2-1-4 materials, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastic constants, position lifetimes, microwave, absorption-pairing and multigap structure in high Tc materials, applications of high Tc materials.

Chhindwara University, Chhindwara(MP)
Session :- 2020-21

Unit V

A. Materials of Solid State Devices

Rectifiers, transistors, capacitors-IV-V compounds, low-dimensional quantum structures; optical properties.

B. Organic Solids, Fullerenes, Molecular Devices

Conducting organics, organic superconductors, magnetism in organic materials.

Fullerenes-doped, fullerenes as superconductors.

Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage **memory and switches-sensors.**

Nonlinear optical materials; nonlinear optical effects, second and third order-molecular hyperpolarisability and second order electric susceptibility — materials for second and third harmonic generation.

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Chhindwara University, Chhindwara(MP)
Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Polymers

Paper/प्रश्न पत्र : IV OPT-2

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

Particulars/विवरण

Unit I

Basics

Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition/radical chain-ionic and copolymerization. Polymerization condition and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

Unit II

Polymer Characterization

Poly dispersion -average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity an molecular weight distribution. The practical significance of molecular weight: Measurement of molecular-weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods.

Unit III

Analysis and testing of polymers

Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact, tear, resistance, Hardness and abrasion resistance.

Unit IV

Inorganic Polymers

A general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers.

Structure, Properties and Applications of

a. Polymers based on boron-borazines, boranes and carbpranes.

b. Polymers based on Silicon, silicone's poly metalloxanes and poly metallo siloxanes, silazanes.

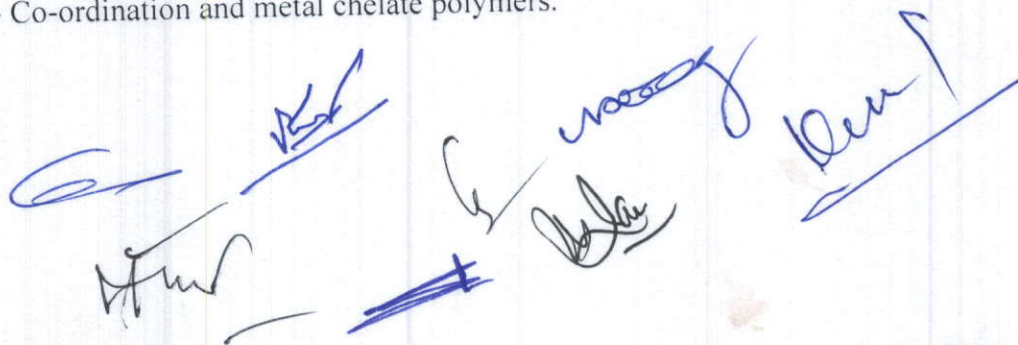
Unit V

Structure, Properties and Application of Polymers

a- Polymers based on Phosphorous-Phosphazenes, Polyohosphates

b- Poylmers based on Sulphur-Tetra sulphur teranitride and reated compounds.

c- Co-ordination and metal chelate polymers.



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Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Heterocyclic Chemistry

Paper/प्रश्न पत्र IV : OPT-3

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

Particulars/विवरण

- Unit I **Nomenclature of Heterocycles**
Replacement and systematic nomenclature (Hantzsch MCH-Widman system) for monocyclic fused and bridged heterocycles.
Aromatic Heterocycles
General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in ¹H NMR-spectra. Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.
- Unit II **Non-aromatic Heterocycles**
Strain-bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction. Stereoelectronic effects anomeric and related effects. Attractive interactions-hydrogen bonding and intermolecular nucleophilic electrophilic interactions. Heterocyclic synthesis-principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.
- Unit III **Small Ring Heterocycles**
Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxetanes and thietanes.
Benzo-Fused Five-Membered Heterocycles
Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes.
- Unit IV **Meso-ionic Heterocycles**
General classification, chemistry of some important meso-ionic heterocycles of type-A and B and their applications.
Six-Membered Heterocycles with one Heteroatom
Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and phridones. Synthesis and reactions of quonlizinium and benzopyrylium salts, coumarins and chromones.
Six Membered Heterocycles with Two or More Heteroatoms: Synthesis and reactions of diazoles, triazines, tetrazines and thiazines. Seven-and Large-Membered Heterocycles: Synthesis and reactions of azepines, oxepines, thiepinines, diazepines, thiazepines, azocines, diazocines, dioxocines and dithiocines.
- Unit V **Heterocyclic Systems Containing P, As, Sb and B**
Heterocyclic rings containing phosphorus: Introduction, nomenclature, synthesis and characteristics of 5- and 6-membered ring systemsphosphorinaes, phosphorines, phospholanes and phospholes. Heterocyclic rings containing As and Sb : Introduction, synthesis and characteristics of 5- and 6-membered ring system. Heterocyclic rings containing B : Introduction, synthesis reactivity and spectral characteristics of 3- 5- and 6-membered ring system.

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Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Physical Organic Chemistry

Paper/प्रश्न पत्र IV: OPT-4

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

Particulars/विवरण

- Unit I Concepts in Molecular Orbital (MO) and Valence Bond (VB) Theory
Introduction to Huckel molecular orbital (MO) method as a mean to explain modern theoretical methods. Advanced techniques in PMO and FMO theory, Molecular mechanics, semi empirical methods and ab initio and density functional methods. Scope and limitations of several computational programmes.
- Unit II **Quantitative MO theory** : Huckel molecular orbital (HMO - method as applied to ethene, allyl and butadiene. Qualitative MO theory ionisation potential. Electron affinities. MO energy levels. Orbital symmetry. Orbital interaction diagrams. MO of simple organic systems such as ethene, allyl, butadiene, methane and methyl group. Conjugation and hyper-conjugation. Aromaticity.
Valence bond (B) configuration mixing diagrams. Relationship VB configuration mixing and resonance theory. Reaction profiles. Potential energy diagrams. Carve. Crossing model-nature of activation barrier in chemical reactions.
- Unit III **Principles of Reactivity**
Mechanistic significance of entropy, enthalpy and Gibb's free energy. Arrhenius equation. Transition state theory. Uses of activation parameters, Hammonds postulate, Bell-Evaris Polanyi Principle. Potential energy surface model. Marcus theory of electron transfer. Reactivity and selectivity principles.
Kinetic Isotope Effect
Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect. Solvent effects.
Structural Effects on Reactivity
Linear free energy relationships (LFER). The Hammett equation, substituent constants, theories of substituent effects. Interpretation of δ -values. Reaction constants. Deviations from Hammett equation. Dualparameter correlatins, inductiv subStituent constant. The Taft model, sl and sR scales.
- Unit IV **Acids, Bases, Electrophiles, Nucleophiles and Catalysis**
functions and their applications. hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity.
The α -effect. Ambivalent nucleophiles. Acid-base catalysis-specific and general catalysis. Bronsted catalysis, Nucleophilic and electroPhilic catalysis. Catalysis by noncovalent binding-micellar catalysis.
Steric and Conformation Properties
Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates. Rates. Steric LFET. Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

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Unit V

Nucleophilic and Electrophilic Reactivity

Structural and electronic effects on SN1 and SN2 reactivity. Solvent effect. Kinetic isotope effects. Intramolecular assistance. Electron transfer nature of SN2 reaction. Nucleophilicity and SN2 reactivity based on curved crossing mode. Relationship between polar and, electron transfer reactions, SRN1 mechanism. Electrophilic reactivity, general mechanism. Kinetic of SE2 Ar reaction. Structural effects on rates and selectivity. Curve-crossing approach to electrophilic reactivity.

Supramolecular Chemistry

Properties of covalent bonds-bond length, inter-bond angles, force constant, bond and molecular dipole moments. Molecular and bond polarizability, bond dissociation enthalpy, entropy. Intermolecular forces, hydrophobic effects. Electrostatic, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, forces between macroscopic bodies, medium effects. Hydrogen bond.

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Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : III

Title of Subject / विषय का शीर्षक : Industrial Chemistry - Heavy Chemicals & Petroleum

Paper/प्रश्न पत्र : IV OPT-5

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

Particulars/विवरण

Unit I

Water, Gases and Heavy Chemicals

Water: Water Pollutants, their classes with examples, Biochemical Oxygen demand, thermal pollution, pollution by fertilizers, detergents, pesticides and industrial wastes.

Water Purification :

Classical and modern Methods — Ion exchange, electro dialysis, Reverse osmosis. Softening of Hard water. Chlorination and fluoridation.

Unit II

Gases : Chemistry Large-scale production, storage, hazards and uses of the following industrial gases: Hydrogen, oxygen, nitrogen, carbon dioxide, chlorine, fluorine, sulphur dioxide, phosgene, acetylene, argon, neon and helium.

Heavy Chemicals : Manufacture, Physical properties, Analysis, Hazards and applications of the following chemicals :

HCl, H₂SO₄, HNO₃, H₃PO₄, polyphosphoric acid,

NaHCO₃, Na₂CO₃, NaOH, NaCl, Na₂S₂O₃, Bleaching Powder, Bromine.

Unit III

Coal & Petroleum

Coal: Origin and economic importance of coal. Coal composition, Coal carbonization, Coal gasification, Coal Gas, Water Gas, Producer gas, coal tar industry and manufacture of coal tar based chemicals and their importance. Role as carcinogens, Non-fuel uses of coal, and Cl Chemistry based on MeOHCOCO₂. CH₄ and CH₂O.

Unit IV

Petroleum: Origin and composition, Refining, Reforming Fractionation; Cracking; knocking and Octane number, Kerosene and Napthe; Liquified. Petroleum gas (I.P.G.) Synthetic Gas, Synthetic Petrol, Petrochemicals, manufacture of ethylene propylene. Butedmne, xylenes, etc. Economic importance with particular reference to India.

Unit V

Fats & Oils

Fats & Oil Natural Fats, Edible and Industrial Oils of vegetable origin, Common fatty acids and glycerides. Hydrogenation of Unsaturated oils, manufacture of Vasaspati and margarine.



Chhindwara University, Chhindwara (M.P.)

Session :- 2020-21

M.Sc. Chemistry semester II

Paper : V

OPT :- VI

Organo Transition metal Chemistry

Max.Marks:- 40+10 CCE

Min. Marks :- 15+04 CCE

UNIT I

Alkyls and Aryls of Transition Metals :- Types, routes of synthesis, stability and decomposition pathways, organo copper in organic synthesis

UNIT II

Compounds of Transition Metal-Carbon Multiple Bonds :- Alkylidenes, alkylidynes, low valent carbenes and carbynes-synthesis, nature of bond structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

UNIT III

Transition Metal π -Complexes :- Transition metal π -complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

UNIT IV

Transition Metal Compounds with Bonds to Hydrogen ;

Homogeneous catalysis :- Stoichiometric reactions for catalysis homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.

UNIT V

Fluxional Organometallic Compounds :- Fluxionality and dynamic equilibria in compounds such as n^2 -olefin, n^3 -allyl and dienyl complexes.

Books Suggested

- Principles and Applications of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
- The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley
- Metallo-organic Chemistry, A.J. Pearson, Wiley
- Organometallic Chemistry, R.C. Mehrotra and A.Singh, New Age International

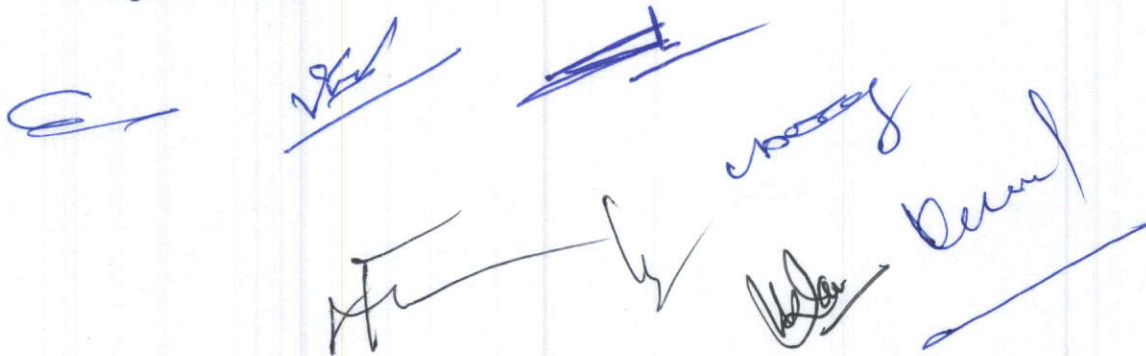
INORGANIC - Chemistry

Practical-Chemistry MS.c Semester- III

Qualitative determinations of a three components mixture	-	8
Chromatographic Separations	-	8
Spectrophotometric analysis	-	8
Record	-	5
Viva-Voce	-	5

Marks - 34

- 1- Qualitative determinations of a three components mixture - One Volumetrically and two gravimetrically
 - a. Cu^{+2} , Ni^{+2} , Zn^{+2}
 - b. Cu^{+2} , Ni^{+2} , Fe^{+++}
- 2- Chromatographic Separations : Thin Layer Chromatographic separation
 - a. Cadmium and Zinc
 - b. Zinc and Magnesium
 - c. Nickel and Manganese
 - d. Cobalt and Nickel
- 3- Mole ratio method and continuous variation method for Fe-salicylic acid Fe-SCN complexes spectrophotometric method for determination of concentration of an inorganic compound. KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$



छिन्दवाड़ा विश्वविद्यालय, छिन्दवाड़ा

Session -2019-2020

Class/कक्षा
Semester/सेमेस्टर
Subject/विषय
Paper
विषय समूह का शीर्षक

M.Sc.

III

Chemistry

III

Physical Chemistry (Practical)

Physical Chemistry	12
Spectroscopy	12
Chemical Kinetics	04
Record	05
Viva Voice	33
Total	

Spectroscopy

- I. Determination of pKa of indication (e.g. methyl red) in (a) aqueous and (b) micellar media
- II. Determination of stoichiometry and stability constant of Ferriisothiocyanate complex ion in Solution.
- III. Determination of rate of alkaline bleaching of Malchite green and effect of ionic strength on the rate of reaction.
- IV. Determination of stability constant of Fe(III)- salicylic acid complex.
- V. Lambert Beers Law.

Chemical Kinetics

- I. Determination of rate constant formation constant of an intermediate complex in the reaction of Ce (IV) and Hypophosphorous acid at ambient temperature.
- II. Determination of energy and enthalpy of activation in the reaction of KMnO₄ and benzyl alcohol in acid medium.
- III. Determination of energy of activation of and entropy of activation from a single kinetic run.
- IV. Kinetics of an enzyme micellar catalyzed reaction.
- V. Determination of order of S₂O₈²⁻ - I reaction
- VI. Determination of energy of activation of S₂O₈²⁻ - I reaction
- VII. Studies on the effect of variation of ionic strength on the rate of S₂O₈²⁻ - I reaction
- VIII. Ester hydrolysis catalyzed by a base
- IX. Kinetics of acid-catalyzed reaction between acetone-iodine.

Practical

MS.c. Semester – III

Duration – 6-8 hours in each branch

Organic Chemistry

Max Marks – 33

Marks - 8

Multi-step Synthesis of Organic Compounds

- The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.
- Preparation in steps: Benzophenone Benzopinacol Benzopincolone Beckmann rearrangement : Benzophenone from benzene.
- Benzene- Benzophenone- Benzophenone Oxime Benzanilide.
- Benzilic acid rearrangement: Benzilic acid from benzoin.
- Benzoin- Benzil- Benzilic
- Synthesis of heterocyclic compounds Skraup synthesis.
- Preparation of quinoline from aniline.
- Fisher Indole synthesis: Preparation of 2- Phenylindole from phenylhydroxime.
- Preparation of phenolphthalein
- Preparation of fluorescein
- Preparation of eosin from fluorescein

Marks- 4

Isolation

- Isolation of nicotine from tobacco leaves preparation of coloured candle and analysis.
- Preparation of some commercial organic products-**
Preparation of some commercial organic products such as insecticide and pesticide.

Marks- 4

Interpretation of spectra

- I R spectra of phenols & Alcohols, Naphthol's, Aldehydes, ketones and Acids.
- U.V. spectra of butadiene, acyclic diene, ketone, phenol, unsaturated carboxylic acid

Marks- 4

Communication Skills:

- Presentation Skills : (1) How to make power point presentation
(2) Body language during presentation

Viva - 4

Record – 5

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Chhindwara University, Chhindwara (M.P.)

SYLLABUS OF M.A./M.Com./M.Sc./M.H.Sc. PREVIOUS/FINAL OR SEMESTER IV

Name of Paper	Title of paper	Max. Marks			Minimum Marks			Total Marks
		Theory	CCE	Practical	Theory	CCE	Practical	
I	Application of Spectroscopy II	40	10		15	04		50
II	Solid State Chemistry	40	10		15	04		50
III	Bio-Chemistry	40	10		15	04		50
IV and V optional	1. Organic Synthesis	40	10		15	04		50
Group A	2. Analytical Chemistry	40	10		15	04		50
	3. Electro Chemistry	40	10		15	04		50
Group B	1. Chemistry of Natural products	40	10		15	04		50
	2. Medicinal Chemistry	40	10		15	04		50
	3. Industrial Chemistry - Pesticides and Glass Industry	40	10		15	04		50

Board of Studies :

- I. Chairperson *[Signature]*
- II. Subject Expert -

1. *[Signature]*
2. *[Signature]*
3. *[Signature]*
4. *[Signature]*

Practicals Max. Min.

- | | | |
|-----------|----|----|
| Inorganic | 34 | 13 |
| Organic | 33 | 13 |
| Physical | 33 | 13 |

Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Application of Spectroscopy – II

Paper/प्रश्न पत्र : I

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	Ultraviolet and Visible spectroscopy Various electronic transitions (185-800 nm) Beer-Lambert law, Effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic compounds. Steric effect in biphenyls.
Unit II	Infrared Spectroscopy Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and fermi resonance.
Unit III	Nuclear Magnetic Resonance of Paramagnetic Substances in Solution The contact and Pseudo contact shifts, factors affecting nuclear relaxation, some applications including biochemical systems, an overview of NMR of metal nuclide with emphasis on ^{195}Pt and ^{119}Sn NMR.
Unit IV	Carbon-13 NMR Spectroscopy General considerations, chemical shift (aliphatic olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy-COSY, NOESY, DEPT:II-NBC and HMQC techniques.
Unit V	Mass Spectrometry Introduction production EI, CI, FD, E-3,1 and FAB, factors affecting fragmentation, ion analysis, ion abundance Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak. Me Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Structure elucidation of simple molecules using UV — Visible, IR, NMR and mass spectral techniques.



Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Solid State Chemistry

Paper/प्रश्न पत्र : II

Max. Marks/अधिकतम अंक : 40+10 CCE Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	Solid State Reactions General principles, experimental procedure, co-precipitation as a precursory to solid state reactions, kinetics of solid state reactions.
Unit 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 Frenkel defect formation, colour centres, non-stoichiometry and defects.
Unit III	Electronic Properties and Band Theory Metals insulators and semiconductors, electronic structure of solidsband theory band structure of metals, insulators and semiconductors, Intrinsic and extrinsic.. semiconductors, doping semiconductors, p-n junctions, super conductors. Optical properties-Application of optical and electron microscopy. Magnetic Properties- . Classification of materials : Effect of temperature calculation of magnetic moment, mechanism of ferro and anti ferromagnetic ordering super exchange.
Unit IV	Organic Solids Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors.
Unit V	Liquid Crystals: Types of liquid crystals: Nematic, Smectic, Ferroelectric, Antiferroelectric, Various theories of LC, Liquid crystal display, New materials.

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Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Biochemistry

Paper/प्रश्न पत्र : III

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	<p>Metal Ions in Biological Systems Bulk and trace metals with special reference to Na, K, Mg, Ca, Fe, Cu, Zn, Co, and K⁺/Na⁺ pump. Bioenergetics and ATP Cycle. DNA polymerisation, glucose storage, metal complexes in transmission of energy; chlorophyll's, photosystem I and photosystem II in cleavage of water.</p> <p>Transport and Storage of Dioxygen Haem proteins and oxygen uptake structure and function of haemoglobin's, myoglobin, haemocyanins and hemerythrin, Model synthetic complexes of iron, cobalt and copper.</p>
Unit II	<p>Electron Transfer in Biology Structure and function of metal of proteins in electron transport processes cytochrome's and iron-sulphur proteins, synthetic models. Nitrogen fixation Biological nitrogen fixation, and its mechanism, nitrogenase, Chemical nitrogen fixation.</p>
Unit III	<p>Enzymes Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michael's-Menten and Lineweaver Burk plots, reversible and irreversible inhibition. Mechanism of Enzyme Action. Transition-state theory, orientation and Steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase.</p> <p>Kinds of Reactions Catalysed by Enzymes Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in Isomerisations reactions, β-Cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.</p>



Unit IV	<p>Co-Enzyme Chemistry Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD⁺, NADP⁺, FMN, FAD, lipoic acid, vitamin B 12. Mechanisms of reactions catalyzed by the above cofactors.</p> <p>Enzyme Models Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality Biometric chemistry, crown ether, cryptates. Cyclodextrins, cyclodextrin-based enzyme models, clixarenes, ionospheres, micelles synthetic enzymes or synzymes.</p> <p>Biotechnological Applications of Enzymes large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry-brewing and cheese-making, syrups from corn starch, enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA Technology.</p>
Unit V	<p>Biological Cell and its Constituents Biological cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coils transition.</p> <p>Bioenergetics Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.</p> <p>Biopolymer Interactions Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibrium and various type of binding processes in biological systems. Hydrogen ion titration curves.</p> <p>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.</p>



Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

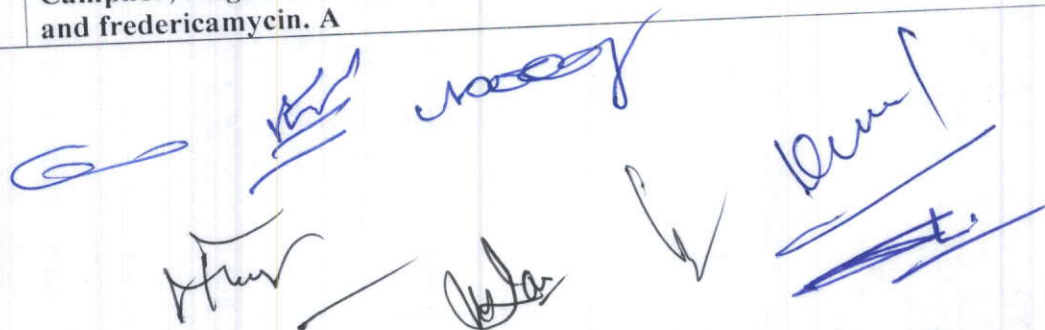
Title of Subject / विषय का शीर्षक : Organic Synthesis

Paper/प्रश्न पत्र : IV OPT-1

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	Disconnection Approach An introduction to synthons and synthetic equivalents. Disconnection approach, functional group inter-conversions, the importance of the order events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reaction, amine synthesis. Protection of groups, chemo, region and stereo selectivity.
Unit II	One Group C-C Disconnections Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic Nitro compounds in organic synthesis. Two Group C-C Disconnections Diels-Alder Reaction, 1,3-difunctionalised compounds, a-b-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation.
Unit III	Oxidation Introduction, Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated) Alcohols, diols, aldehyde's, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium. (III) Nitrate. Reduction Introduction, Different reductive processes. Alkanes, alkenes, alkynes, and aromatic rings. arbonyl compounds-aldehydes, ketones, acids and their derivatives.Epoxi10. Nitro, nitroso, azo and oxime groups. Expoxide, Nitro, Nitroso, azo and oxime groups.
Unit IV	Organometallic Reagents Principle, preparations, properties and applications of the following in organic synthesis metallic Reagents with mechanistic details. Group I and II metal organic compounds Li, Mg, Hg, Cd, Zn and Ce.Compounds.
Unit V	Synthesis of some complex molecules: Application of the above in the synthesis of following compounds : Camphor, longifoline, cartisone, reserpine, vitamin D, juvabion aphidicolin and fredericamycin. A



Chhindwara University, Chhindwara(MP)

Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Chemistry of Natural Products

Paper/प्रश्न पत्र :IV OPT-2

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	Terpenoids and Carotenoids Calcifications, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Chitral, Geraniol α -Terpinol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β -Carotene.
Unit II	Alkaloids Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, (+)- Coniine, -Nicotine, Atropine, Quinine and Morphine.
Unit III	Steroids Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone, Biosynthesis of Steroids.
Unit IV	Plant Pigments Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin Quercetin, Myrcetin, Quercetin 3-glucoside, Vitexin, Diadzein, Aureusin, Cyanidin-7arabinoside, Cyaniidin, Hirsutidin, Biosynthesis of flavonoids: Acetate pathway and Shikimic a pathway. Prophyrins Structure and synthesis of Hemoglobin and Chlorophyll.
Unit V	Prostaglandin Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE2 and PGF2a. Pyrethroids and Rotenones Synthesis and reactions of Pyrethroids and Rotenones. (For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).

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Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Analytical Chemistry

Paper/प्रश्न पत्र : IV

Code : OPT- 3

Max. Marks/अधिकतम अंक : 40+10 CCE Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	<p>Introduction Role of analytical chemistry Classification of analytical methods classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neactness and cleanliness. laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware cleaning and calibration of glassware. Sample Volumetric glassware cleaning and Calibration of glassware. Sample preparation-dissolution and decompositions. Gravimetric techniques. Selecting and handling or reagents. Laboratory notebooks. Safety in the analytical laboratory.</p> <p>Errors and Evaluation Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data determinate (systematic), indeterminate (or random) and gross. Sources of error and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics.</p>
Unit II	<p>Food analysis Moisture, ash, crude protein, fat crude fiber, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination of foods stuffs. Microscopic, examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC. Gas chromatography for organophosphates. Thin-layer chromatography for identification of chlorinates pesticides in food products.</p>
Unit III	<p>Analysis of Water Pollution Origin of Waste water, types, water pollutants and their effects. Sources of water pollution-domestic, industrial agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis-parameter for analysis-colour, turbidity, total solids, conductivity, acidity, alakalinity, hardness, chloride, sulphate, fluoride, silica, phosphates adn different forms of nitrogen, Heavy metal pollution-public health significance of tadmium, chromium, copper, lead, zinc, managanese, mercurry and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems'. Measurements of DO, BOD, and COD. Pesticides as water pollutants and analysis. Water pollution law; and standards.</p>
Unit IV	<p>Analysis of soil, Fuel, Body Fluids and Drugs (a) Analysis of Soil, moisture pH total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.</p>

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	<p>Fuel analysis : liquid and gas. Ultimate and proximate analysis-heating values-grading of coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-produced gas and water gas-calorific value.</p>
Unit V	<p>(a) Clinical Chemistry : Composition of blood-collection and preservation nr samples. Clinical analysis. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphates. Immunoassay: principles of radio immunoassay (RIA) and applications. The blood gas analysis trace elements n the body</p> <p>(b) Drug analysis : Narcotics and dangerous drug. Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.</p>









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Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Electrochemistry

Paper/प्रश्न पत्र : IV OPT-4

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	<p>1. Conversion and Storage of Electrochemical Energy Present status of energy</p> <p>Consumption: Pollution problem. History of fuel cells, Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter.</p> <p>Physical interpretation of the Carnot efficiency factor in electrochemical energy converters. Power output.</p> <p>Electrochemical Generators (Fuel Cells) : Hydrogen Oxygen cells, Hydrogen Air cell, Hydrocarbon air cell, Alkane fuel cell, Phosphoric and fuel cell, direct NaOH fuel cells, applications of fuel cells.</p> <p>Electrochemical Energy Storage :</p> <p>Properties of Electrochemical energy storage : Measure of battery performance, Charging and discharging of a battery, Storage Density, Energy Density. Classical Batteries.</p> <p>i (i) Lead Acid</p> <p>ii (ii) Nickel – Cadmium</p> <p>iii (iii) Zinc manganese dioxide, Modern Batteries : (i) Zinc-Air (ii) Nickel – Metal Hydride (iii) Lithium Battery, Future Electricity Stores : Storage in (i) Hydrogen (ii) Alkali Metals, (iii) Non aqueous solutions.</p>
Unit II	<p>Corrosion and stability of Metals:</p> <p>Civilization and Surface mechanism of the corrosion of the metals;</p> <p>Thermodynamics and the stability of metals, Potential –pH (or Pourbaix) Diaphragms; uses and abuses, Corrosion current and corrosion potential – Evans diagrams. Measurement of corrosion rate : (i) Weight Loss method (ii) electrochemical Method.</p> <p>Inhibiting Corrosion :</p> <p>Cathodic and Anodic Protection . (i) Inhibition by addition of substrates to the electrolyte environment (ii) by charging the corroding method form external source anodic Protection, Organic inhibitors, The Fuller Story Green inhibitors.</p> <p>Passivation :</p> <p>Structure of Passivation films, Mechanism of Passivation, Spontaneous Passivation Nature's method for stabilizing surfaces.</p>

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Unit III	<p>Bio electrochemistry Bioelectrodes, Membrane Potentials, Simplistic theory, Modern theory, Electrical conductance in biological organism : Electronic, Protonic electrochemical mechanism of nervous systems, enzymes as electrodes. Kinetic of Electrode Process : Essentials of Electrode reaction : Current Density, Overpotential, Tafel Equation, Butler Volmer equation. Standard rate constant (k_0) and Transfer coefficient (α), Exchange Current. Irreversible Electrode processes : Criteria of irreversibility, information from irreversible wave.</p>
Unit IV	<p>Methods of determining kinetic parameters for quasi-reversible and irreversible waves : Koutecky's methods, Meits Israel Method, Gellings method Electrocatalysis Chemical catalysts and Electrochemical catalysts with special reference to putostates, porphyrin oxides of rare earths. Electrocatalysis in simple redox reactions, in reaction involving adsorbed species. Influence of various parameters.</p>
Unit V	<p>Potential Sweep Method : Linear sweep Voltammetry, Cyclic Voltammetry, theory and applications. Diagnostic criteria of cycli vltammetry. Controlled current microelectrode techniques : comparison with controlled potentials methods, chronopotentiometry, theory ad applications. Bulk Electrolysis Methods : Controlled potential coulometry, Controlled Coulometry, Electroorganic synthesis and its important applications. Stripping analysis : anodic and Cathodic modes, Pre electrolysis and Stripping steps, applications of Stripping Analysis.</p>

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Session :- 2020-21

Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

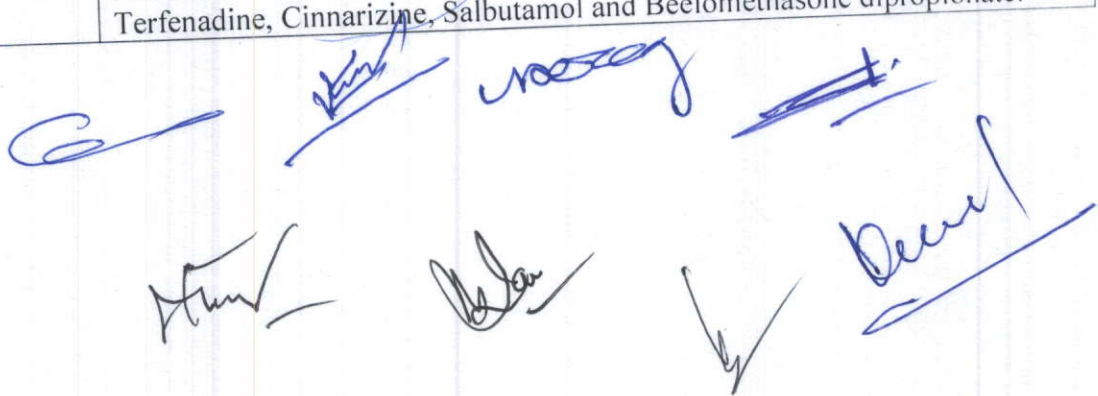
Title of Subject / विषय का शीर्षक : Medicinal Chemistry

Paper/प्रश्न पत्र : IV OPT- 5

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	Structure and activity: Relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Introduction to combinatorial synthesis in drug discovery. Factors affecting bioactivity. QSAR-Free-Wilson analysis, Hansch analysis, relationship between Free-Wilson analysis and Hansch analysis.
Unit II	Pharmacodynam: Introduction, elementary treatment of enzymes stimulation, enzyme inhibition, sulfonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.
Unit III	Antibiotics and antibacterials Introduction, Antibiotic β -Lactam type - Penicillins, Cephalosporins, Antitubercular — Streptomycin, Broad spectrum antibiotics — Tetracyclines, Anticancer — Dactinomycin (Actinomycin D)
Unit IV	Antifungal — polyenes, Antibacterial — Ciprofloxacin, Norfloxacin, Antiviral — Acyclovir Antimalarials : Chemotherapy of malaria. SAR. Chloroquine, Chloroguanide and Mefloquine
Unit V	Non-steroidal Anti-inflammatory Drugs : Diclofenac Sodium, Ibuprofen and Netopam Antihistaminic and antiasthmatic agents : Terfenadine, Cinnarizine, Salbutamol and Beclomethasone dipropionate.



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Class/ कक्षा : M.Sc. Chemistry

Semester/ सेमेस्टर : IV

Title of Subject / विषय का शीर्षक : Industrial Chemistry- Pesticides and Glass Industries

Paper/प्रश्न पत्र : IV

Code : OPT- 6

Max. Marks/अधिकतम अंक : 40+10 CCE

Min. Marks/न्यूनतम अंक : 15+04 CCE

	Particulars/विवरण
Unit I	Cleansing Agents Cleansing Agents : Toilet and washing soaps; preparation and uses, Synthetic detergents; alkyl aryl sulfonates, fatty alcohol surfaces, ethanalamines , nonionic detergents.
Unit II	Fertilizers and Inorganic Materials: Fertilizers : Fertilizers Industries in India, Manufacture of Ammonium salts. Urea, Nitrates, Phosphates and Super phosphates, Nitrogen fixation. Glass: Types, their composition and properties testing glass. Manufacture of Glass Fibres. Optical Glass, Colored Glasses, Lead Glass and Neutron Absorbing Glass. Ceramics: Important clays and feldspar. Glazing and vitrification, Glass ceramics.
Unit III	Cement : Types and their manufacture, setting process. Ferrous Industry: Manufacture of steel and other important alloys. Silicon : Pre silicon, Electronics Industry.
Unit IV	Pesticides and Food additives Pesticides and Food additives : Classification, important categories of insecticides, fungicides, herbicides and rodenticial; Mode of action.
Unit V	Chemistry and synthesis of corn i pesticides : Such and Tabun. Sarin, Davgon, DDYP



INORGANIC - CHEMISTRY

Practical-Chemistry MS.c Semester- IV

Analysis	-	8
Preparation	-	8
Spectral Compound	-	8
Record	-	5
Viva-Voce	-	5

Marks - 34

1- Analysis of cement :

Analysis of Ca^{2+} in cement

Estimation of Fe^{3+} in cement

Analysis of Alloys : Brass and bronze analysis

Analysis of Soldering Material

2- Preparation and spectral studies

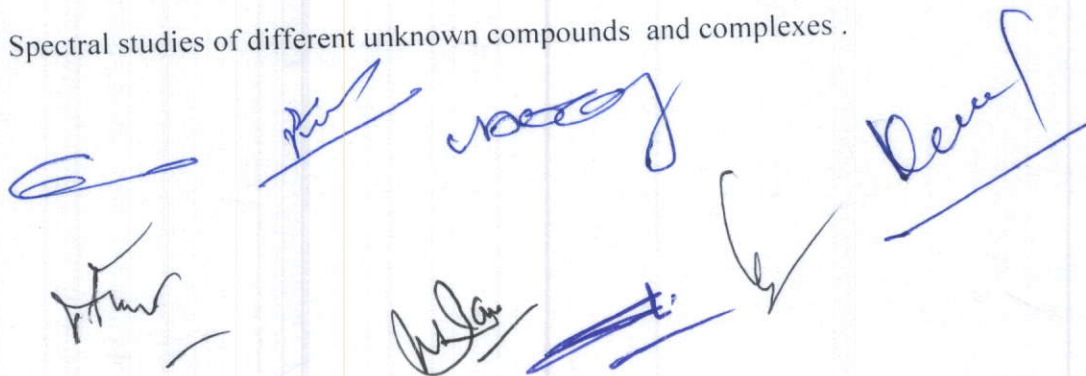
1. Sodium tetra thionate

2. Metal complex of dimethyl Sulphoxid

3. Cis and trans $[\text{Co}(\text{en})_2 \text{Cl}_2]$

4. $[\text{Cr}(\text{H}_2\text{O})_6]\text{NO}_3$

3- Spectral studies of different unknown compounds and complexes .



Practical

M Sc. Semester – IV

Duration – 6-8 hours in each branch

Organic Chemistry

Max Marks – 33

Multi Step Synthesis of Organic Compounds

Marks-6

1. Biosynthesis of ethanol from sucrose.
2. Preparation of picric acid from phenol.
3. Preparation of malachite green.
4. Preparation of phenolphthalein
5. Preparation of fluorescein.
6. Preparation of eosin from fluorescein.
7. Green synthesis of paracetamol, adipic acid, ibuprofen, and catechol.

Interpretation of spectra

- IR spectra of phenols & Alcohols, Naphthols, Aldehydes, ketones and Acids and derivative.
- U.V. spectra of butadiene, acyclic diene, ketone, phenol, unsaturated carboxylic acid derivative.

Marks-4

Analysis

Marks-4

Analysis of dyes, natural flowering material (flavones, flavonols, anthocyanin) by chromatographic separation technique method (TLC, paper column chromatography).

Preparation of some commercial organic products and make their PPT.

1. Preparation of soap and detergent.
2. Preparation of coloured candles.
3. Preparation of organic herbicides/ insecticide.

Marks-6

Communication Skills:

Marks-4

1 Scientific writing: Writing a Scientific Report on a project undertaken or an experiment conducted. (theory+ practice)

2 Group discussion: Group discussion on some current scientific topics.

Record- 4
Viva-5

MSc IV Sem

Physical Chemistry

Max marks : - 33

Practical III

Conductometry	8
Potentiometry/pH metry	8
Polarimetry/Spectrophotometry	8
Record	4
Viva Voce	5

Potentionmetry

1. Acid-base titration
2. Titration of mixture of acids
3. Redox titrations
4. Determination of redox potential of Fe(III)/Fe(II) System

Conductivity

5. Verification of Onsager equation for a strong electrolyte
6. Determination of dissociation constant of a weak acid
7. Acid-base titration, Determination of Solubility and solubility product
8. Replacement titration
9. Solubility of sparingly a soluble salt
10. Basicity of an organic acid

pH metry

11. Acid Base Titration
12. Determination of the dissociation constant and Activity and Activity Coefficient

Spectrophotometry

13. Verification of Beer-Lambert law
14. Determination of pka of an acid-base indicator such as Methyl Red

Polarimetry

15. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
16. Enzyme kinetics-inversion of sucrose.

