ANDHRA UNIVERSITY

DEPARTMENT OF CHEMISTRY

PROGRAM : M.SC INORGANIC CHEMISTRY

REGULATION AND SYLLABUS

EFFECTIVE FROM 2020-2021 BATCH

ANDHRA UNIVERSITY

SCHOOL OF CHEMISTRY

DEPARTMENT OF INORGANIC & ANALYTICAL CHEMISTRY

Revised Syllabus for M.Sc. INORGANIC CHEMISTRY

(With effect from the Admitted batch of 2021-2022 Academic Year)

Programme Objectives

1. Provide the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of inorganic chemistry
2. To give firm foundation in the fundamentals and application of current chemical and scientific theories.
3. To inculcate critical thinking and analytical reasoning as applied to scientific problems.
4. To motivate critical thinking and analysis skills to solve complex chemical problems, e.g., analysis of data, synthetic logic, spectroscopy, structure and modeling, team-based problem solving, etc.
5. To demonstrate an ability to conduct scientific experiments as well as accurately record and analyze the results of such experiments.
6. To inculcate understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
7. To demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.

Programme Outcomes:

Students after completing M.Sc. Inorganic chemistry course shall

PO1: Be able to demonstrate basic knowledge in the core areas of chemistry (analytical, general, inorganic, organic, physical, applied chemistry etc).

PO2: Have firm foundations in the fundamentals of inorganic chemistry and important real world applications of many of these aspects.

PO3: Be versatile in classical laboratory techniques(qualitative and quantitative analysis), use instrumental methods for chemical analysis of inorganic compounds as well as follow standardized procedures and regulations in handling and disposal of chemicals.

PO4: Become post graduates with the skills to critically assess and solve problems requiring the application of chemical principles.

PO5: Equip students with effective scientific communication skills

Programme Specific Outcomes of M.Sc. Programme with Inorganic Chemistry

PSO1:- Provide theoretical background and develop practical skills for synthesis and analysing inorganic materials using modern analytical methods and instruments

PSO2:- Inculcate a problem solving approach by coordinating the different branches of chemistry

PSO3:- Becomes professionally skilled for higher studies in research institutions and to work in chemical industries.

PSO4:- In-depth knowledge helps to qualify in competitive exams like CSIR-NET, APSET, and GATE etc.

REGULATIONS

1. The duration of the course is for two academic years with total four semesters. The nature of the course is full-time.
2. Candidates for the degree of Master of Science in Chemistry shall be required to have passed the B.Sc with Chemistry / Applied Chemistry / Industrial Chemistry as one the subject of this university or any other university recognized by the academic council as equivalent thereto.
3. The course and scope of instruction shall be as defined in the syllabus prescribed. (Annexure-III)
4. Candidate who takes instruction shall be required to take examinations at the end of each semester as specified in Annexure-I.
5. Each candidate has to undergo an internship for a duration of four weeks during the fourth semester in any chemical industry/ R&D / organization/ or at the department at their own expense and have to submit project report.
6. A candidate shall be declared to have passed in any course if he /she secures not less than "E" grade in theory and not less than "D" grade in the practical /Project, provided the result otherwise is withheld. There is no minimum pass marks for internal assessment marks both theory as well as practical.

A candidate shall be deemed to have satisfied the minimum requirement for the award of the degree of M.Sc. Chemistry.

i. If he / she is declared to have passed all the subjects included in the scheme of instruction and examination and
ii. if he /she secures 5.0 CGPA in each of the semesters by the end of the fourth semester.

Further, a candidate shall be permitted to choose any course(s) to appear for improvement in case the candidate fails to secure the minimum prescribed SGPA/CGPA to enable the candidate to pass at the end of any semester examinations. There shall not be any provision for the improvement of internal assessment marks in any theory or practical subjects in any year /semester of study. Grades and calculation of SGPA and CGPA are given in Annexure-II

7. The successful candidates in the M.Sc Chemistry degree examination shall be arranged in the order in which they are registered for the examination in the following classes on the basis of the CGPA. However, students who pass in any supplementary examination shall not be awarded Distinction even if they obtain a CGPA of 8.0 or above, they shall be considered as First Class only.

First Class with Distinction	– CGPA 8.0 or more
First Class	– CGPA 7.0 or more but less than 8.0
Second Class/Pass	– CGPA 5.0 or more but less than 7.0

8. The Question course setting and valuation shall be as per the University regulations at the end of each semester.
9. The practical examinations shall be conducted and valued by both internal and external examiners at the end of each semester.
10. The viva- voce examination for Project Work shall be conducted both internal and external examiners at the end of the completion of project and after submission of the Project Report by each of the candidates.
11. The Minimum attendance required by a candidate will be 75% of the total number for

the working days in that semester. Provided that in special cases and for sufficient cause shown, the Vice-chancellor may, on the recommendation of the Principal and the Head of the department concerned, condone the deficiency in the average attendance to an extent of 9% for reasons such as ill health, if the application for condonation is submitted at the time of actual illness and is supported a certificate of an authorized medical officer approved by the Principal. However, 100% attendance should be maintained for all practicals/ labs/ Internship>

12. Each of the student has to study two MOOC courses from NPTEL/SWAYAM etc. one in the third semester and the other in the fourth semester of the programme and the grade obtained should be submitted to the Department/ College/ University for incorporation in the marks list along with the Grade/ Course Completion Certificate. The Departmental Committee shall decide whether to accept or not the grade/score obtained by the student. The student has to complete each of these courses during the concerned semester period only.
13. Keeping in view of the objectives of NPE 2020 and the directives of the University, two value added courses have been included each in 3rd and 4th semesters of the course. Intellectual Property rights in 3rd semester and Research Methodology in the 4th semester under non-credit scheme. However, the students have to attend the examination and pass the examination similar to that of other subjects of the course.
14. The University may, from time to time, revise, amend or change the regulations, scheme of examination and syllabus. In the case of students already undergoing the course, the changes will take effect from the beginning of the following academic year after the change are introduced and shall cover the part of the course that remains to be completed.

COURSE STRUCTURE OF M.Sc. INORGANIC CHEMISTRY SPECIALIZATION

SEMESTER –I

Course code	Course Title	Course type (Theory/ Practical)	Instruction periods per week	Internal Marks	External Marks	Total Marks	Duration of Examination	Credits
SCS-117	General Chemistry-I	Theory	04	20	80	100	3 hrs	04
SCS-118	Inorganic Chemistry-I	Theory	04	20	80	100	3 hrs	04
SCS-119	Organic Chemistry-I	Theory	04	20	80	100	3 hrs	04
SCS-120	Physical Chemistry-I	Theory	04	20	80	100	3 hrs	04
PR-347	Inorganic Chemistry Laboratory-1	Practical	06	15	60	75	3 hrs	03
PR-348	Physical Chemistry Laboratory-1	Practical	06	15	60	75	3 hrs	03
PR-349	Organic Chemistry Laboratory-1	Practical	06	15	60	75	3 hrs	03
		Total	34					25

SEMESTER –II

Course code	Course Title	Course type (Theory/ Practical)	Instruction periods per week	Internal Marks	External Marks	Total Marks	Duration of Examination	Credits
SCS-215	General Chemistry-II	Theory	04	20	80	100	3 hrs	04
SCS-216	Inorganic Chemistry-II	Theory	04	20	80	100	3 hrs	04
SCS-217	Organic Chemistry-II	Theory	04	20	80	100	3 hrs	04
SCS-218	Physical Chemistry-II	Theory	04	20	80	100	3 hrs	04
PR-350	Inorganic Chemistry Laboratory-1I	Practical	06	15	60	75	3 hrs	03
PR-352	Physical Chemistry Laboratory-I1	Practical	06	15	60	75	3 hrs	03
PR-351	Organic Chemistry Laboratory-1I	Practical	06	15	60	75	3 hrs	03
		Total Number of credits						25

III semester

Course Code	Course Title	Course Type	Instruction Periods per week	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
SCIS-307	Paper-I: Solid State Chemistry -1	Theory	4	80	20	100	3 hours	4
SCIS308	Paper-II: Structure, Bonding and Reactivity of coordination compounds – I	Theory	4	80	20	100	3 hours	4
SCIS-309	Paper-III: Bio-inorganic Chemistry	Theory	4	80	20	100	3 hours	4
SCIS-312	Paper-IV: Physical Methods In Inorganic Chemistry-I	Theory	4	80	20	100	3 hours	4
PR-725	Practical - I: Classical Methods of Analysis	Lab	3	80	20	100	6 hours	4
PR-725	Practical - II: Instrumental Methods of Analysis	Lab	3	80	20	100	6 hours	4
		Total:				600		24

Non Credit Courses:

PR-A1328	MOOCs Course		-	-	-	-	-	4
	Add-on Course on "Intellectual Property Rights"		-	-	-	-	-	2

IV semester

Course Code	Course Title	Course Type	Instruction Periods per week	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
SCIS-411	Paper-I: Solid State Chemistry -II	Theory	4	80	20	100	3 hours	4
SCIS-407	Paper-II: Structure, Bonding and Reactivity of coordination compounds – II	Theory	4	80	20	100	3 hours	4
SCIS408	Paper-III: Organometallic Chemistry	Theory	4	80	20	100	3 hours	4
SCIS-414	Paper-IV: Physical Methods In Inorganic Chemistry-II	Theory	4	80	20	100	3 hours	4
PR-A1328	Project Work	Lab	-	100	-	100	-	4
PR-726	Practical - I: Classical Methods of Analysis	Lab	3	80	20	100	6 hours	4
PR-726	Practical - II: Instrumental Methods of Analysis	Lab	3	80	20	100	6 hours	4
VV-646	Viva-Voce			50	-	50	6 hours	2
		Total:				750		30

Non Credit Courses:

PR-A1328	MOOCs Course		-	-	-	-	-	4
	Add-on Course on "Intellectual Property Rights"		-	-	-	-	-	2

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-I
PAPER-I: GENERAL CHEMISTRY-I
(Effective from the admitted batch of 2021-2022)

Course Outcomes (COs)/Course Specific Outcomes (CSOs):

Upon completion of the course the students will be able to,

CO1: Learn and understand the selection rules and criteria for molecules to exhibit rotational and IR spectroscopy.

CO2: Understand the Classical and quantum mechanical theories of Raman spectroscopy and basic concepts of electronic spectroscopy.

CO3: Learn spectroscopic methods based on magnetic resonance principles.

CO4: Learn basics of group theory and its application in chemistry.

CO5: Understand the basic concepts of FORTRAN programming and its applications.

Learning Outcomes (LOs):

Upon completion of the course the student will be able

- To apply the spectroscopic methods for structure elucidation of molecules.
- To acquire knowledge of molecular symmetry and group theory and to solve chemical problems.
- To write FORTRAN programs for simple chemical problems.
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COURSE CONTENT

UNIT – I **[15 Hours]**

Rotational spectra of diatomic molecules-rigid rotor-selection rules-calculation of bond length-isotopic effect, second order stark effect and its applications, Infrared spectra of diatomic molecules-harmonic and anharmonic oscillators. Selection rules-overtones-combination bands calculation of force constant, anharmonicity constant and zero point energy. Fermi resonance, simultaneous vibration rotation spectra of diatomic molecules.

UNIT-II **[15 Hours]**

Raman effect-classical and quantum mechanical explanations-Rotational Raman and vibrational Raman spectra, Electronic spectra of diatomic molecules-Vibrational coarse structure-intensity of spectral lines-Franck Condon principle-applications, Rotational fine structure-band head and band shading, Charge transfer spectra.

UNIT-III **[15 Hours]**

Spin Resonance Spectroscopy: Principle and theory of NMR spectroscopy-Nature of spinning particle and its interaction with magnetic field. Chemical shift and its origin. Spin-Spin interaction-experimental methods. Application of NMR to structural elucidation-Structure of ethanol, dimethylformamide, styrene and acetophenone. Principle and theory of ESR-g-factor, hyperfine interactions-applications of ESR studies to the structure of free radicals, metal complexes.

UNIT-IV **[15 Hours]**

Basic concepts of Symmetry and Group theory – Symmetry elements, symmetry operations and point groups – Schoenflies symbols – Classification of molecules into point groups – Axioms of Group theory – Group multiplication tables for C_{2V} and C_{3V} point groups – Similarity Transformation

and classes – Representations – reducible and irreducible representations, Mulliken symbols, Orthogonality theorem and its implications, character table and its anatomy.

UNIT-V **[15 Hours]**

Basic components of Computers, higher and lower level languages, Microsoft Fortran: constants, variables and operators, arithmetic expressions, assignment and replacement statements, Input and Output statements – Format free and Format directed I/O statements – Iw, Fw.d, Ew.d and Gw.d format specifications, conditional and unconditional statements – Logical IF, Block IF and Go To statements, Do statement – syntax and rules.

Application of Chemical Problems:

Flowcharts and Programs for

1. Statistical Analysis calculation of arithmetic mean, mean deviation, variance and standard deviation of replicate measurements.
2. Solution of Quadratic equation – calculation of the roots of a quadratic equation.
3. Calculation of the pH and hydrogen ion concentration of an aqueous solution of a strong acid taking into account the auto ionization of water.
4. Calculation of the root of a polynomial using Gauss-Newton method – Application to Vander-Waal's equation.
5. Calculation of the rate constant of a first order reaction or calculation of molar extinction coefficient using Beer-Lambert's Law by Linear least-squares method.

Text Books:

1. Symmetry and Spectroscopy of Molecules, K Veera Reddy, New Age International Publishers.
2. Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press.
3. Chemical Applications of Group Theory, F. A. Cotton Wiley Eastern Limited New Delhi.
4. Group Theory and its Applications to Chemistry, K. V. Raman, Tata McGraw – Hill Publishing Company Ltd., New Delhi.
5. Computer programming in Fortran-IV by V .Rajaraman, Prentice-Hall of India Pvt. Ltd., New Delhi.
6. Molecular Spectroscopy, - Gordon M. barrow
7. Fundamentals of Molecular Spectroscopy – Banwell.

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-I
PAPER-II: INORGANIC CHEMISTRY-I
(Effective from the admitted batch of 2021-2022)

Course Objectives: To make the students

CO 1: Acquiretheknowledgeon applications of VSEPR, Valence Bond and Molecular orbital theories in explaining the structures of simple molecules **and** role of p and d orbitals in pi bonding.
CO 2: Understand the concept of MO theory to square planar ($PtCl_4^{2-}$) and Octahedral complexes (CoF_6^{3-}, $Co(NH_3)_6^{3+}$). And Walsh diagram for H_2O molecule
CO 3:Apply theknowledgeandunderstandingofUnderstand the Orgel and Tanabe-Sugano diagrams for d^1 –d^9 octahedral and tetrahedral transition metal complexes of 3d series stonewly prepared metal complexex
CO 4:Develop interest in the areas of magnetic properties of transition and inner transition metal complexes – spin and orbital moments – quenching of orbital momentum by crystal fields in complexes.
CO5: To understand the concept of Term symbols and Electronic spectra and Magnetic properties of complexes

Learning Outcomes: At the end of the course, the learners should be able to:

LO 1:Explainidea of structure and bonding theories of inorganic compounds
LO 2:InterpretWalsh diagram for other liner and bent molecules
LO 3:Introduce electron counting rules for higher boranes
LO 4:Analyse the preparation and structures of heteropoly acids
LO 5:Understanding structure and bonding in coordination compounds
LO 6:Explain selections rules, Tanabe-Sugano diagrams. Orgel diagrams

LO7: Experimentally Identify the covalency in metal complexes.
LO8:To calculate the magnetic susceptibility of metal complexes
LO9: understand and analyse structure-property correlation of coordination compounds

LO10:design new coordination compounds based on a fundamental understanding of their

electronic properties

COURSE CONTENT

UNIT-1 **[12 Hours]**

Structure & Bonding: Applications of VSEPR, Valence Bond and Molecular orbital theories in explaining the structures of simple molecules- role of p and d orbitals in pπ-dπ bonding, Bent's rule, Non-valence cohesive forces

Application of MO theory to square planar ($PtCl_4^{2-}$) and Octahedral complexes (CoF_6^{3-}, $Co(NH_3)_6^{3+}$).

Walsh diagrams for linear (BeH_2) and bent (H_2O) molecules

UNIT-II **[12 Hours]**

Inorganic cage and ring compounds – preparation, structure and reactions of boranes, carboranes, metallocarboranes, boron–nitrogen ($H_3B_3N_3H_3$), phosphorus–nitrogen ($N_3P_3Cl_6$) and sulphur-nitrogen (S_4N_4, $(SN)_x$) cyclic compounds. Structure and bonding in higher boranes with (special reference to B12 icosahedra). Electron counting rules in boranes – Wades rules (Polyhedral skeletal electron pair theory).

Polyacids: Introduction to polyacids- Types of polyacids- Isopolyacdis, Isopoly molybdates, Isopolytungstates, Isopolyvanadates, Structures of Polyacids $]Mo_7O_{24}],^{6-}(V_{10}O_{28})^{6-}$ and $W4O_{16}]^{8-}$, Heteropolyacids- properties of heteropolyacids and salts, structures of heteropolyacids and theories , Mialalicopause and Roscnneium theories , Pauling's theory and keggin's theory, applications of polyacids.

UNIT-III **[12 Hours]**

Coordination compounds: Crystal field theory - crystal field splitting patterns in octahedral, tetrahedral, tetragonal, square planar, square pyramidal and trigonal bipyramidal geometries. Calculation of crystal field stabilization energies. Factors affecting crystal field splitting energies – Spectrochemical series, Jahn – Teller theorem (static and dynamic Jahn-Teller theorem) and its consequences, nephelauxetic effect, applications and limitations of CFT; ligand field theory

Experimental evidences for covalence in complexes. Molecular Orbital Theory of bonding for Octahedral, tetrahedral and square planar complexes. π-bonding and MOT - Effect of π - donor and π -acceptor ligands on Δo. Experimental evidence for π - bonding in complexes

UNIT- IV **[12 Hours]**

Electronic spectra of transition metal complexes:

Term symbol-Free Ion terms and Energy Levels: Configurations, Terms, States and Microstates, calculation of Microstates for P^2 and d^2 Configuration, Russell- Saunders Coupling Schemes, J-J Coupling scheme, derivation of terms for various configurations P^2 and d^2 configuration, spectroscopic Ground state , Hole Formalism, Energy ordering of terms (Hund's Rules), Selection rules: Laporte orbital selection rule, spin selection rules. Splitting of energy levels and spectroscopic states Orgel diagrams of d^1 to d^9 metal complexes. Interpretation of electronic spectra of aquo Complexes of Ti(III), V(III), Cr(III), Mn(II), Fe(II), Fe(III), Co(II), Ni(II) and Cu(II). Calculation of interelectronic and spectral parameters for d^8 metal complexes.

UNIT- V **[12 Hours]**

Tanabe- Sugano diagrams for d^1 –d^9 octahedral and tetrahedral transition metal complexes of 3d series. Calculation of Dq, Racah Parameter (B) and nephelauxetic parameter (β), Charge transfer (L→M and M→L) spectra of metal complexes.

Magnetic properties of metal Complexes: Types of magnetic behavior, Temperature independent paramagnetism. Magnetic properties of transition and inner transition metal complexes – spin and orbital moments – quenching of orbital momentum by crystal fields in complexes. Magnetic susceptibility and its determination by Gouy's method, and Faraday's method. orbital contribution to magnetic moment ($O_h$and T_d Complexes)

Text books:

1. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkinson, IV Edition, John Wiley and Sons, New York, 1980.
2. Inorganic Chemistry by J.E. Huheey, III Edition, Harper International Edition, 1983.
3. Theoretical Inorganic Chemistry, II Edition by M.C. Day and J. Selbin, Affiliated East-West press Pvt. Ltd., New Delhi.
4. Inorganic Chemistry by Shriver and Atkins, Oxford University Press (1999)

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-I
PAPER-III: ORGANICCHEMISTRY-I
(Effective from the admitted batch of 2021-2022)

Course Objectives: To make the students

CO 1: Acquiretheknowledgeofaliphaticnucleophilic,aliphaticelectrophilic,stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

CO 2: Understand aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic ccompounds and chemistry of natural products

CO3: Apply the knowledge and understanding of aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products to new situations

CO 4: Develop interest in the areas of aliphatic nucleophilic, aliphatic electrophilic,stereochemistry and conformational analysis, chemistry of heterocyclic compoundsandchemistryofnaturalproducts

Learning Outcomes: At the end of the course, the learners should be able to:

LO 1: Explainaliphaticnucleophilic,aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

LO 2: Interpretaliphaticnucleophilic,aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocycliccompounds and chemistry ofnaturalproducts

LO 3: Comparealiphaticnucleophilic, aliphaticelectrophilic,stereochemistryandconformational analysis, chemistry of heterocycliccompounds and chemistry ofnaturalproducts

LO 4: Analysealiphaticnucleophilic,aliphaticelectrophilic,stereochemistryandconformational analysis, chemistry of heterocycliccompounds and chemistry ofnaturalproducts

LO 5:SolvealiphaticnucleophillG,aliphaticelectrophilic,stereochemistryandconformational analysis, chemistry of heterocycliccompounds and chemistry ofnaturalproducts

LO6: Identify aliphatic nucleophilic,aliphaticelectrophilic, stereochemistry and conformation alanalysis, chemistry of heterocyclic compounds and chemistry of natural products

LO7:Apply aliphaticnucleophilic,aliphaticelectrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

COURSE CONTENT

UNIT–I **[15 Hours]**

Aliphatic Nucleophilic Substitutions: The SN2, SN1, SNi and SET mechanisms.Substitutionreactionsofambidentnucleophiles,anchimericassistance,theneighbouring group mechanism: neighbouring group participation by 0,N, S,halogens, aryl groups, alkyl and cycloalkyl groups in nucleophilic substitutionreactions. Sigma, Pi bond participation in acylic and bicyclic systems (Non- classiccarbocations).NucleophilicSubstiłutional allylic,ŁrigonalandVinyliccarbons.Effectofsubstrate,attackingnucleophile,leavinggroupandreactionmedium .

UNIT-II **[15 Hours]**

Aliphatic ElectrophilicSubstitutions: SEI SE2 and SEi mechanisms. Reactivity-effects of substrate, leaving group and solvent. Reactions- hydrogen exchange,migration of doublebonds, halogenation of aldehydes, ketones, carboxylic acids, acylhalides,sulphoxidesandsulphones.

UNIT-III **[15 Hours]**

Stereochemistry and Conformational Analysis: Optical Isomerism:FtiCal activity,moleculardissymmetryand chirality- elements of symmetry.Fisher'sprojectionD,L. and R,S. configurations - relative and absolute configurations optical isomerismdue to asymmetric carbon atoms - optical isomerism in biphenyls, allenes andspirans-opticalisomerismofnitrogenouscompounds,racemisationandresolution.

Geometricalisomerism:E,Z-configurations,propertiesofgeometricalisomers.Conformationalanalysis:Conformationsofacyclicmolecules-alkanesandsubstitutedalkanes-compoundshavingintramolecularhydrogenbonding.Conformations of cyclohexane, mono and disubstituted cyclohexanes and decalins,effectofconformationsonreactivity.

UNIT—IV **[15 Hours]**

Chemistry of Heterocyclic Compounds :Structure, reactivity and synthesis of threemembered Heterocycles: (a) Oxirane: Sharpless method, Shi epoxidation, Jacobsenepoxidation, etc, (b) Aziridine; four membered Heterocycles: (a) Oxetane (b) Azetine;five memberedHeterocycles:(a) Pyrrole: Paa1 Knorr, Hantzsch Methods,etc, (b)Thiophene: Paa1 Knorr, Hinsberg method, etc. (c) Furan: Paa1 Knorr, Fiest-Benary,IndustrialMethod, etc.; (d) Pyrazole,(e) Imidazole,(f) Oxazole, (g) Thiazole; Sixmembered Heterocycles: (a) Pyridine, (b)Pyridazine,(c) pyrimidine and (d) Pyrazine;Aromatic heterocyclics: a) Indole: Fischer indole synthesis, Bischler synthesis, andMadelungsynthesis(b)QuinolineandIsoquinoline,(c)CoumarinsandChromones.

UNIT—V **[15 Hours]**

ChemistryofNaturalProducts:

A) Terpenoids:- Occurrence,Isolation,isoprenerule,structureelucidationandsynthesisofn-Terpineolandn-pinene

B) Steroids:-Nomenclatureofsteroids,structureelucidation,synthesisandstereochemistry of cholesterol and progesterone

C) Lipids:-Classification,propertiesandfunction-freefattyacids,triglycerides,phospholipids,glycolipids&waxesconjugatedlipids-lipoproteins

ReferenceBooks

1. AdvancedOrganicChemistry:ReactionsMechanismsandStructurebyJerryMarch,

Mc.GrawHillandKogakush.

2. OrganicChemistryVol.I(Sixth Ed.)andVol.II(FifthEd.)byILFinarELBS.

3. OrganicChemistry(fifthEd.,)byMorrison andBoyd,PHI,India.

4. OrganicChemistry(fifthedition)byFrancisA.CareyTataMcGrawHillpublishing CompanyLimited,NewDelhi.

5. StereochemistryofOrganiccompoundsbyErnestL.E1ie1,SamuelH.Wilen

6. Chemistry of natural products by S. V. Bhat, B. A. Nagasampangi and M.Sivakumar NarosaPublishingHouse,6threprint2010

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-I

PAPER-IV: PHYSICALCHEMISTRY-I

(Effective from the admitted batch of 2021-2022)

Course Outcomes (COs)/Course Specific Outcomes (CSOs)

Upon completion of the course the students will be able to,

CO1: Explain the basic concepts of Thermodynamics and its applications

CO2: Understand the concepts of thermodynamics of solutions.

CO3: To understand the principle of micellisation.

CO4: Understand the various kinetic theories, measurements of reaction rates.

CO5: Learn experimental techniques for measuring the kinetics of fast reactions and homogenous catalyzed reactions.

Learning Outcomes (LOs):

Upon completion of the course the student will be able to understand

- To apply the concepts of thermodynamics to various problems in chemistry.
- To predict various reaction mechanisms.
- To apply the concept of micellization to various chemical reactions.

COURSE CONTENT

UNIT-I **[15 Hours]**

Basic concepts of second law of Thermodynamics-Entropy- Entropy changes accompanying different processes-Entropy changes in an ideal gas, entropy changes in the mixing of ideal gases, entropy as a function of V and T and entropy as a function of P and T-Entropy change in isolated systems- Clausius inequality-Helmholtz and Gibbs energy - Maxwell relations - Criteria for spontaneity-variation of Gibbs energy with temperature and pressure for solids, liquids and gases-Concept of fugacity-determination of fugacity coefficient of gases- Thermodynamics of phase transitions- Concept of chemical potential-Location of phase boundaries- (Clausius-Clapeyron equation for Liquid- Vapour, Solid - Liquid and Solid- Vapour boundaries)- Ehrenfest classification of phases.

UNIT-II **[15 Hours]**

Thermodynamics of mixtures -partial molar quantities - experimental methods of determination of partial molar quantities -Gibbs-Duhem equation and Duhem-Margules equation-Thermodynamics of mixing of liquids (ΔH_{mix}, ΔG_{mix} and ΔS_{mix}) - Thermodynamics of ideal solutions - Raoult's law -Thermodynamics of colligative properties of dilute solutions - concept of activity and activity coefficient- Experimentaldetermination of activity coefficient - Thermodynamic concept of equilibrium, variation of equilibrium with temperature (Van't Hoff equation) and pressure - Nernst heat theorem, Third law of thermodynamics- exceptions to third law of thermodynamics.

UNIT-III **[15 Hours]**

Surface tension- Capillary action- Adsorption-Adsorption isotherms- Freundlich adsorption isotherm, Langmuir adsorption isotherm-limitations - BET adsorption isotherm-estimation of Surface area.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.

UNIT-IV **[15 Hours]**

Chemical Kinetics: Theories of reaction rates- Collision theory- Limitations, Transition state theory.Lindeman's theory of unimolecular reactions -Limitations. Diffusion controlled reactions. Effect of ionic strength on rates of reactions- Primary and secondary salt effects. Effect of dielectric constant onreactions - kinetic isotope effect -Primary and secondary isotopic effects -Effect of substituent -Linear free energy relationships - Hamett equation -limitations- Taft equation. Kinetics of consecutive reactions, parallel reactions, opposing reactions (Uni molecular steps only, no derivation).

UNIT-V **[15 Hours]**

Specific and general acid-base catalysis. Skrabal diagrams. Steady state approximation- Enzyme catalysis- Michaelis -Menten mechanism. Derivation of Kinetic equation and Kinetic parameters. Lock and Key hypothesis-pH dependence of enzyme catalyzed reactions.Fast reactions- different methods of studying fast reactions- flow methods, relaxation methods- temperature jump and pressure jump methods.

Text Books:

1. Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press.
2. Chemical Kinetics by K. J. Laidler, McGraw Hill Pub.
3. Physical chemistry by K.L. Kapoor

Reference Books:

1. Thermodynamics for Chemists, Samuel Glasstone
2. Physical chemistry by Puri, Sharma and Pathania
3. Micelles, Theoretical and applied aspects, V. Moroi, Plenum publisher

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SCHOOL OF CHEMISTRY
DEPARTMENT OF INORGANIC & ANALYTICAL CHEMISTRY
SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-I

PRACTICAL-I: INORGANICCHEMISTRY

(Effective from the admitted batch of 2021-2022)

Course Objectives:

CO 1: To develop an insight into the preparation of inorganic complexes

CO 2: To understand the process of preparation of inorganic complexes

CO 3: To acquire skills in the preparation of inorganic complexes

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Prepare various inorganic complexes

LO 2: Develop skill in handling apparatus, measure the quantities and carryout the reaction and analyze the inorganic mixtures

LO 3: Applies the skill in preparing new metal complexes and analysis of inorganic mixtures

LO4: Understand the regulations in handling and disposal of chemicals.

COURSE CONTENT:

1. **Synthesis of Inorganic Metal Complexes:**Synthesis of 3d transition metal complexes of tetrahedral, square planar and octahedral geometries.
   (i) Preparation of TetraammineCopper(II) sulphate monohydrate
   (ii) Potassium tris-oxalatoferrate (III) trihydrate
   (iii) Tris-thiourea copper(I) sulphate
2. **Systematic SemimicroQualitative Analysisof Inorganicsix radical mixtures**
   In systematic Semi micro qualitative inorganic analysis, inorganic mixture containsthree cations and three anions. The analysis involves identification and conformation of cations and anions containing one less familiar cation(Tungsten, Molybdenum, Zirconium, Thorium, Titanium, Uranium, Cerium, Vanadium, Lithium, Berkelium Etc... and one interfering anion

Anions: CO_3^{2-} , S^{2-} , SO_3^{2-} , Cl^- , Br^- , I^- , NO_3^- , SO_4^{2-}, CH_3COO^-, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, PO_4^{3-} , CrO_4^{2-}, AsO_4^{3-}, F^- , BO_3^{3-}

Cations : Ammonium (NH_4^+),1st group: Hg, Ag, Pb, Tl, W ; 2nd group: Hg, Pb, Bi, Cu, Cd, As, Sb, Sn, Mo; 3rd group: Fe, Al, Cr, Ce, Th, Ti, Zr, V, U, Be

4th group: Zn, Mn, Co, Ni5th group: Ca, Ba, Sr6th group: Mg,K, Li

Note: A minimum of 4 inorganic mixtures must be analysed in this Semester

REFERENCE BOOKS:

1. Practical Inorganic Chemistry, G. Marr and B. W. Rockett.
2. Practical Inorganic Chemistry by G.Pass H.Sutchiffe,2nd edn John Wiley & Sons.
3. Experimental Inorganic/Physical Chemistry, M. A. Malati, Horwood Publishing, Chichester, UK (1999)

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SEMESTER-I

PRACTICAL-II: PHYSICALCHEMISTRY

(Effective from the admitted batch of 2021-2022)

Course Objectives:

CO 1: To maintain laboratory ethics, safety and cleanliness

CO 2: To Preparation and standardization of solutions

CO 3: To have hands-on experience/practical knowledge in performing Physical chemistry experiments

CO 4: To develop skills on handling instruments like conductometry and perform different types of acid-base titrations

CO 5: To plot accurate graphs of the desired scale for the calculations of Langmuir and Freundlich isotherms

CO 6: To Prepare the solution of the desired concentration and the desired volume in Cuprammonium cation.

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: To be able to develop/practical skills to solve problems in chemistry.

LO 2: To extend the principle of Conductometric titration to other kind of reactions.

LO 3: To learn to use the concept of phase diagram for different systems

LO 4: To apply adsorption isotherms for other reactions.

COURSE CONTENT:

1. Conductometry
   a) Conductometric titration of strong acid (HCl) vs strong base (NaOH)
   b) Conductometric titration of weak acid (CH_3COOH) vs strong base (NaOH)
   c) Conductometric titration of mixture of acids (HCl + CH_3COOH) vs strong base (NaOH)
2. Determination of Cell constant of conductivity cell
3. Determination of Dissociation constant of weak acid by conductometric Method
4. Determination of Critical solution temperature of phenol-Water system
5. Determination of effect of electrolyte (NaCl) on the miscibility temperature of Phenol-Water system
6. Determination of composition of Cuprammonium cation using partition coefficient method
7. To verify Langmuir and Freundlich isotherm for absorption of acetic acid onto activated Charcoal

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SEMESTER-I

PRACTICAL-III: ORGANICCHEMISTRY

(Effective from the admitted batch of 2021-2022)

Course Objectives:

CO 1: To develop an insight into the preparation of organic compounds in various reactions

CO 2: To understand the process of preparation of organic through various reactions

CO 3: To acquire skills in the preparation of organic compounds, their separation, purification and identification

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Prepare various organic compounds using various reactions

LO 2: Develop skill in handling apparatus, measure the quantities and carryout the reaction, separate the products, purify them and analyze the products formed

LO 3: Applies the skill in preparing novel organic moieties

COUSE CONTENT:

Synthesis of Organic compounds

Synthesis, purification and characterization of about ten organic compounds involving one or two stages.

List of some suggested compounds

1. β-Napthyl methyl ether from β-Naphthol
2. m-dinitrobenzene from Nitrobenzene
3. Azo dye from primary amine
4. Aromatic acid from ester
5. Benzanilide from aniline
6. p-nitroaniline from Acetanilide
7. p-Bromo acetanilide from aniline
8. Phthalimide from phthalic acid
9. 1,2,3-Tribromo benzene from aniline
10. Benzanilide from Benzophenone

Text Books:

1. A Textbook of Practical Organic Chemistry by A. I. Vogel, ELBS and Longman group.
2. Practical Organic Chemistry by Mann and Saunders, ELBS and Longman group.

MODEL QUESTION PAPER

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SEMESTER-I

Paper- I: GENERAL CHEMISTRY-I

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questionsMax. Marks**: 80 **(5x16=80 Marks)**

1. (a) (i)What kind of molecules exhibit microwave spectra.
   (ii) Discuss isotope effect in microwave spectra.

(or)

(b) (i)Derive an expression for energy or harmonic oscillator and discuss the selection rules.
   (ii) Describe the origin of PQR structure of Vibrational-Rotational spectra.

2. (a)(i) Discuss the classical and quantum mechanical theories of Raman spectra.
   (ii) Explain rotational fine structure in electronic spectroscopy?

(or)

(b) (i)State and explain Franck Condon principle.
   (ii) Write a short note on charge transfer spectra.

3 (a) (i)Explain the terms spin active nuclei, resonance, larmor precession and chemical shifts in NMR.
   (ii) Explain hyperfine interactions in ESR spectroscopy taking examples.

(or)

(b) (i)What are the factors affecting g value in ESR spectroscopy.
   (ii) Explain spin-spin interactions in NMR spectroscopy?

4 (a) (i)State and explain the axioms of group theory.
   (ii) State the great Orthogonality theorem and discuss its implications.

(or)

(b) (i)Give the points groups for NH_3, XeF_4, eclipsed C_2H_6, Cis C_2H_4, $B_3N_3H_6$ and allene.
   (ii) Describe the anatomy of character table.

5 (a) (i)Write a flowchart and FORTRAN program for calculation of rate constant of a first order reaction.
   (ii) Give the syntax and rules of DO statement.

(or)

(b) (i)Write a flowchart and FORTRAN program for calculation of pH and hydrogen ion concentration of an aqueous solution of a strong acid taking into account the auto ionization of water.
   (ii) Write a brief note on format directed Input/output statements.

MODEL QUESTION PAPER

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SEMESTER-I

Paper- II: INORGANIC CHEMISTRY-I

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questions** **Max. Marks**: 80 **(5x16=80 Marks)**

1. (a) (i)Predict the geometries of ClF_3, XeF_4 and SF_4 molecules using VSEPR theory.
(ii)What is LCAO method? Predict bond order and bond lengths in O_2^+ and O_2^- ions based on MO energy level diagram

OR

(b) (i)Draw the MO energy level diagram for $[Co(NH_3)_6]^{3+}$ and discuss its magnetic properties.
(ii) Draw the Walsh diagram for H_2O molecule and predict its structure.

2. (a) (i)Discuss the preparation of, structure of, and bonding in $N_3P_3Cl_6$.
(II) Discuss the structure and properties of borazole.

OR

(b) (i)Explain Mialalicopause and Roscnneium theories, Pauling's theory and keggin's theory of polyacids.
(ii) Explain the method of counting skeletal electrons in cluster compounds

3. (a) (i)Draw and explain the crystal field splitting of 'd' orbitals in square planar and trigonal bipyramidalgeometries.
(ii) Discuss the factors affecting crystal field splitting energies.

OR

(b) (i) what are static and dynamic Jahn-Teller theorem and discuss its consequences
(ii) Write a note on nephelauxetic effect

4. (a) (i)How do Tanabe – Sugano diagrams differ from Orgel diagrams? Draw Tanabe – Sugano diagram for $[V(H_2O)_6]^{3+}$
(ii) Draw the Orgel diagram for $[TiCl_4]^-$ ion and explain the electronic transitions.

OR

(b) (i)Write an account on Russell – Saunders coupling.
(ii) Derive the term symbols for Ni^{2+} and identify the ground state term symbol

5. (a) (i)Discuss different types of paramagnetic behaviourof transition metal complexes
(ii) Calculate the spin only magnetic moments of the $[MnCl_6]^{3-}$ and $[Fe(CN)_6]^3$

OR

(b) (i)Describe the Magnetic properties of inner transition metal complexes
(ii) Determination of magnetic susceptibility a determination by Gouy's and Faraday's methods

MODEL QUESTION PAPER

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DEPARTMENT OF INORGANIC & ANALYTICAL CHEMISTRY

SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION

SEMESTER-I

Paper- III: ORGANIC CHEMISTRY-I

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questions** **Max. Marks**: 80 **(5x16=80 Marks)**

1. a.**(i)**Explain SN2 reaction with stereo chemical evidence.

   (ii) What are non-classical carbocations? Explain them.

   (or)

   b. (i)Describe neighbouring group participation reactions of Oxygen and Halogens with an examples

   (ii) Write a note on nucleophilic substitution reactions at allylic and trigonal carbons

2. a. (i) Explain SE1 and SE2 reactions with examples

   (ii) Write a note on halogenations of ketones and carboxylic acidswith examples.

   (or)

   b.(i) Write a note on SE^i reaction and Migration of double bonds

   (ii) Describe halogenations of sulphoxide and sulphones.

3. a. (i) Explain Optical isomerism of biphenyls and spirans.

   (ii) Write about racemisation and resolution with examples.

   (or)

. (b) (i) Describe the properties of geometrical isomers.

   (ii) Write the conformational analysis of cyclohexane with an example.

4. a. (i)Write any two synthesis and reactivity of Oxirane.

   (ii) Explain any two synthesis and reactivity of Indole.

   (or)

   b(i)Describe the synthesis and properties of Pyridine.

   (ii)Write a note on coumarins and chromones with examples.

5 a. (i)Explain the synthesis of α- pinene

   (ii) Write any synthesis of progesterone.

   (or)

   b(i) Explain triglycerides with examples.

   (ii) Write the structure elucidation of cholesterol.

MODEL QUESTION PAPER

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SEMESTER-I

Paper- IV: PHYSICAL CHEMISTRY-I

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questions** **Max. Marks**: 80 **(5x16=80 Marks)**

1. (a) (i)Derive Maxwell's relations.
   (ii) Define fugacity. How do you determine the fugacity of real gases?

(or)

(b) (i)Derive Clausius- Clapeyron equation.
   (ii) Explain the entropy changes accompanying in different processes.

2. (a) (i)Define partial molar quantity? Explain the experimental methods for determining partial molar quantities.
   (ii) Explain briefly about thermodynamics of mixing of liquids.

(or)

(b) (i)State and explain third law of thermodynamics and write its limitations.
   (ii) What is effect of temperature on equilibrium constant?

3 (a) (i)Discuss the features and limitations of Langmuir adsorption isotherm.
   (ii) Give a classification of surface-active agents along with examples.

(or)

(b) (i)What are important features of BET isotherm.
   (ii) What is CMC? What are the factors affecting CMC.

4. (a) (i)Discuss the Lindeman theory of unimolecular reaction and its limitations.
   (ii) Write a note on diffusion-controlled reactions.

(or)

(b) (i)Derive an expression for effect of ionic strength on rate of reaction.
   (ii) Discuss the kinetics of consecutive reactions.

5. (a) (i) Explain the Michaelis-Menten mechanism for enzyme catalysis.
   (ii) Explain the mechanism of specific acid-base catalysis.

(or)

(b) (i) Explain steady-state approximation with examples.
   (ii) Explain temperature jump method for fast reactions and derive an expression for relaxation time.

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SEMESTER-II

PAPER-I: GENERAL CHEMISTRY-II

(Effective from the admitted batch of 2021-2022)

Course Objectives :

CO 1: Students will have the idea of wave function and understand the uncertainty relations

CO2: Students will learn how to solve the Schrödinger Eq. rigorously for model systems

CO 3: Students will be able to understand and be able to explain the origin of quantized energy levels

CO 4: Students will learn to apply concepts from physics and methods from mathematics to derive and understand the properties of chemical systems that arise from quantum mechanical models for the structure of atoms and molecules.

CO 5: They will be able to understand and explain the differences between classical and quantum mechanics

Learning Outcomes:

LO 1: Gain knowledge about Wave equation-interpretation of wave function-properties of wave function-normalization and orthogonalisation.

LO 2: Understand about Symmetry arguments in deriving the selection rules, the concept of tunneling-particle in three -dimensional box. Calculations using wave functions of the particle in a box.

LO 3: Gain knowledge about Perturbation theory-time independent perturbation (only firstorder perturbation is to be dealt with) – application to ground state energy of helium atom

LO 4: Study about variation principle-applications-calculation of zero-point energy of harmonic oscillator-many electron atom

LO 5: Gain knowledge about Valence bond approach-directed valence-hybridization-covalent bond-calculation of ionic and covalent bond contributions in hydrogen molecule

LO 6: Gain knowledge about hydrogen molecule ion – hydrogen molecule (fundamental concepts only)

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SEMESTER-II

Paper I: General chemistry

(w.e.f. 2021-2022 admitted batch)

Unit I **[15 Hours]**

Wave equation – interpretation of wave function – properties of wave function – normalization and orthogonalisation, operators – linear and non-linear commutators of operators, Postulates of quantum mechanics, setting up of operators observables – Hermitian operator – Eigen values of Hermitian operator.

Unit-II **[15 Hours]**

Wave mechanics of simple systems with constant potential energy, particle in one dimensional box – factors influencing colour – transition – dipole integral, symmetry arguments in deriving the selection rules-the concept of tunneling – particle in a three dimensional box, Rigid rotor, wave mechanics of systems with variable potential energy-simple harmonic oscillator-solution of wave equation-selection rules.

UNIT-III **[15 Hours]**

Hydrogen atom-solution of R(r), $\theta(\theta)$ and $\Phi(\phi)$ equations-probability density in orbitals-shapes of orbitals. Perturbation theory-time independent perturbation (only first order perturbation is to be dealt with) – application to ground state energy of hydrogen and helium atom

UNIT –IV **[15 Hours]**

Variation principle-applications to hydrogen and helium atoms-calculation of zero point energy of harmonic oscillator-many electron atom- Comparison between Perturbation and variation theorems. Hartee-Fock self-consistent field method and introductory concepts of Density functional theory(DFT).

UNIT-V **[15 Hours]**

Valence bond approach-directed valence-hybridization-covalent bond-calculation of ionic and covalent bond contributions in hydrogen molecule. Molecular orbital theory – LCAO approximation – hydrogen molecule ion – hydrogen molecule (fundamental concepts only) – The electronic transitions in the hydrogen molecule.

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SEMESTER-II

Paper I: General chemistry

(w.e.f. 2021-2022 admitted batch)

Time: 3 Hours **Maximum marks: 5X16 =80 marks**

(1) (a) i) Derive Schrodinger wave equation?
ii) Explain the postulates of Quantum mechanics

Or

(b) i) Write notes on Hermitian operator and its properties
ii) Explain normalization and orthogonalisation

(2) (a) i) Solve the Schrodinger wave equation for a particle in a one dimensional box.
ii) Write the factors influencing color

Or

(b) i) Derive the Schrodinger wave equation for a simple harmonic oscillator
ii) Describe the concept of tunneling

(3) (a) i) Explain the solutions of R(r), $\theta(\theta)$ and $\Phi(\phi)$ equations of hydrogen atom
ii) Explain probability density in orbitals

Or

(b) i) Explain the time independent perturbation theory to evaluate the ground state energy of helium atom.
ii) Application of above to ground state energy of hydrogen and helium atom

(4) (a) i) What is variation principle. Write its application to calculation of ground state energy of harmonic oscillator.
ii) Compare Perturbation and variation theorems.

Or

(b) i) Explain Hartee-Fock self-consistent field method for multi electron atoms.
ii) Write a note on Density functional theory (DFT)

(5) (a) i) Explain quantum mechanical approach of molecular orbital theory.
ii) Calculate the ionic and covalent bond contributions in hydrogen molecule

Or

(b) i) Discuss the valence bond approach of H_2 molecule.
ii) Write the electronic transitions in the hydrogen molecule.

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SEMESTER-II
PAPER-II: INORGANICCHEMISTRY-II

(Effective from the admitted batch of 2021-2022)

CourseObjectives:Tomakethestudents

CO1:To give a basic and updated knowledge for the students on metal
clusters, Organometallic chemistry of transition metals
CO 2:To discuss the preparation and structures of and functional aspects of metal clusters
CO 3: Design new coordination compounds based on a fundamental understanding of their electronic properties
CO4: To discuss basics principles of reaction mechanism in metal complexes
CO5: To understand the concept of Term symbols and Electronic spectra and Magnetic properties of complexes
LearningOutcomes: Attheendofthecourse,thelearnersshouldbeable to:

LO 1:Explain the idea of metal clusters
LO 2:Interpret the bonding nature in metal clusters
LO 3:understand the basics of inorganic and coordination chemistry
LO 4:verify the 18 electron rules in various metal clusters
LO 5:determine the stability constants of metal complexes
LO6: Explain the kinetics of substitution reaction, conjugate bas mechanism and trans effect
LO 7: design new coordination compounds based on a fundamental understanding of their Reaction mechanism

COURSE CONTENT

UNIT-I **[15 Hours]**

Metal cluster compounds - definition – evidences for existence of M-M bonds - conditions favorable for formation of M-M bonds – preparation, structure and bonding of the following metal cluster compounds.
$Re_2Cl_8^{2-}$, $Mo_2Cl_8^{4-}$, $Re_2(RCOO)_4X_2$, $Mo_2(RCOO)_4(H_2O)_2$, $Cr_2(RCOO)_4(H_2O)_2$, $Cu_2(RCOO)_4(H_2O)_2$, $Cr_2Cl_9^{3-}$, $Mo_2Cl_9^{3-}$, $W_2Cl_9^{3-}$, Re_3Cl_9, $Re_3Cl_{12}^{3-}$, $Mo_6Cl_8^{4+}$, $Nb_6X_{12}^{2+}$ and $Ta_6X_{12}^{2+}$.
Polyatomic clusters – Zintle ions, Chevrel phases.

UNIT-II **[15 Hours]**

Organometallic compounds - 16 and 18 electron rules.
Isoelectronicrelationship - Synthesis, structure, bonding and reactions of carbon monoxide, dinitrogen and nitric oxide complexes.
Isolobal relationship – H, Cl, CH_3, $Mn(CO)_5$; S, CH_2, $Fe(CO)_4$; P, CH, $Co(CO)_3$
Synthesis, structure, bonding and reactions of metallocenes with special reference to ferrocene

UNIT-III **[15 Hours]**

Metal Ligand equilibria in solution:
Step wise and overall formation constants and their interaction. Trends in stepwise constants ((statistical effect and statistical ratio), factors affecting the stability of metal complexes;

Stability correlations - Irwing -William's series, Pearson's theory of hard and soft acids and bases (HSAB), Application of HSAB: Biological functions and toxicology of metals, and medicinal applications; chelate effect and its thermodynamic origin

UNIT-IV **[15 Hours]**

Determination of stability constants of complexes by spectrophotometric method ((Job's method) and pH –metric method(Bjerrum's).

Reactivity of metal complexes – inert and labile complexes. Explanation of lability on the basis of valence bond and crystal field theories.

.UNIT- V **[15 Hours]**

Reaction Mechanisms of Metal Complexes:

Reactivity of metal complexes, inert and labile complexes, Kinetics and mechanisms of substitution reactions, kinetics of substitutions reactions in octahedral complexes, acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism, Anation reactions, substitution reactions in square planar complexes, Trans effect, Mechanism of trans effect, Electron transfer reactions-– concept of complementary and non-complementary reactions with examples, inner sphere and outer sphere mechanisms, Marcus theory.

Text books:

1. Advanced Inorganic Chemistry by F.A. Cotton and R.G. Wilkinson, IV Edition, John, John Wiley and Sons, New York, 1980.
2. Inorganic Chemistry by J.E. Huheey, III edition, Harper International Edition, 1983.
3. Organometallic Chemistry-A unified approach by A. Singh and R.C. Mehrotra, Wiley Eastern Ltd.
4. Inorganic Chemistry by Shriver and Atkins, Oxford University Press (1999)
5. Theoretical Inorganic Chemistry, II Edition by M.C. Day and J. Selbin, Affiliated East-West press Pvt. Ltd., New Delhi.
6. Mechanisims of Inorganic reactions in solution by D.Benson, MCgraw Hill, London, 1968.
7. Inorganic chemistry by K.F. Purcell and J.C.Kotz, W.B. Saunders company, New York, 1977.

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SEMESTER-II

PAPER-III: ORGANICCHEMISTRY-II

(Effective from the admitted batch of 2021-2022)

CourseObjectives:Tomakethestudents

CO 1: Acquire the knowledge of aromaticity, aromatic nucleophilic substitution, reactiveintermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

CO 2: Understand aromaticity, aromatic nucleophilic substitution, reactive intermediatesand name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

CO 3: Apply the knowledge and understanding of aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids to new situations

CO 4: Develop interest in the areas of aromaticity, aromatic nucleophilic substitution, reactive intermediates andnamereactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

Learning Outcomes: At the end of the course, the learners should be able to:

LO 1: Explain aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

LO 2: Interpret aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecularrearrangements, spectroscopy, alkaloids, peptides, proteinsand nucleic acids

LO 3:Compare aromaticity, aromatic nucleophilic substitution, reactive intermediates andnamereactions,molecularrearrangements,spectroscopy,alkaloids,peptides,proteinsand nucleicacids

LO 4:Analyse aromaticity, aromatic nucleophilic substitution, reactive intermediates andnamereactions,molecularrearrangements,spectroscopy,alkaloids,peptides,proteinsand nucleicacids

LO 5: Solve aromaticity,aromaticnucleophilicsubstitution,reactive intermediates andnamereactions,molecularrearrangements,spectroscopy,alkaloids,peptides,proteinsand nucleicacids

LO6: Identify aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

LO7: Apply aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

COURSE CONTENT:

UNIT-I:Aromaticity [15 Hours]

A) **Aromaticity:**Concept of Aromaticity, Aromaticity of five membered, six membered andfusedsystems-non-benzenoidaromaticcompounds:-cyclopropenylcation,cyclobutadienyldication, cyclopentadienyl anion — tropyliumcation and cyclooctatetraenyl dianion—matallocenes,ferrocenes,azulenes,fulvenes,annulenes,fullerenes.Homoaromaticity,Antiaromaticityand Pseudoaromaticity.

B) **Aromatic NucleophilicSubstitutions:** The SNAr, SN1, benzyne and SRN1 mechanisms.Reactivity:Effectofsubstrate,leavinggroupandattackingnucleophile.TheVon-Richter,Somm1et-HauserandSmilesrearrangements.

UNIT-II:ReactiveIntermediatesand Name**Reactions [15Hours]**

A) **ReactiveIntermediates:** Generation,structure,stability andreactivity of Reactiveintermediates: carbanion,carbocation,freeradicals,carbenesandnitrenes.

B) **NameReactions:-**Wittigreaction,Grignardreaction,Storkenaminereaction,Michaeladdition,MannichReaction,Diel's-AlderreactionandEne-reaction,

UNIT-III:MolecularRearrangements [15 Hours]

Molecular**Rearrangements:**

Typesofmolecularrearrangements,migratoryaptitude;

Rearrangements to electron deficient carbon: Pinacol-pinacolone, Wagner-MeerweinandBenzil-Benzilicacid,

Rearrangements toelectron deficientnitrogen: Beckmann,Hofmann,Curtius,SchmidtandLossenrearrangements;

Rearrangementstoelectrondeficientoxygen: Baeyer-villiger,Dakin rearrangements;

Otherrearrangements: Neber rearrangementandFavorskiirearrangements

UNIT-IV:Spectroscopy [15 Hours]

A) UV **Spectroscopy:** Various electronic transitions, selectlon rules, effect of solvent onelectronic transitions, the absorption laws, chromophores, auxochromes, bathochromicandhypso chromic shifts, hyperchromicand hypochromic effects, Woodward-Fieser rules forconjugateddienes andcarbonylcompounds.

B) **Infrared Spectroscopy:** Basic principles: types of molecular vibrations, fingerprint regionandidentificationoffunctionalgroups.

C) **Nuclear Magnetic Resonance Spectroscopy (^{1}H-NMR):** nuclear spin, nuclear resonance,saturation, shielding of magnetic nuclei, chemical shifts, factors affecting the chemical shift,andassignmentofchemicalshifts.

D) Mass **Spectroscopy:** Basic principles, nitrogen rule and fragmentation pattern of carbonylcompoundsandalcohols

UNIT—V: **Alkaloids,Peptides,ProteinsandNucleicacids [15Hour]**

A) ALKALOIDS:Occurrence,Isolation,classificationbasedonnitrogenheterocyclicring andsynthesisofquinineandnicotine

B) **Peptides and Proteins:** o-Aminoacids, their general properties and synthesis,

Synthesis ofpeptidesbyMerrifieldsolid phasesynthesis.Primary, secondaryandtertiary structuresofproteins

C) **Nucleic** acids:Heterocyclic bases; Purines: Adenine and Guanine; Pyramidines: Cytosine,Uracil and Thymine; nucleosides, nucleotides Basic concepts of the structures of RNA andDNA

Text books:

1. Organic Chemistry Vol. I (Sixth Edn.) and Vol. II (Fifth Ed.,) by IL finar ELBS.
2. Organic Chemistry (fifth Edn.,) by Morrison and Boyd, PHI, India.
3. Organic Chemistry (fifth edition) by Francis A. Carey Tata McGraw Hill publishing Company Limited, New Delhi.
4. Reaction Mechanism in Organic Chemistry by Mukherjee Sirigh, N Terniitarr, Indiar

A guide book to mechanism in Organic Chemistry by Peter Sykes, ELBS.
Advanced organic chemistry by Jerry March (4th Edition)Wiley Eastern. .
Stereochemistry of carbon compounds by E.Eliel, John Wiley & Sons, Inc.
Stereochemistry of Organic compounds by D. Nasipuri.
Chemistry of Natural products by R.S. KalsiKalyani Publ

ANDHRA UNIVERSITY
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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-II

PAPER-IV: PHYSICAL CHEMISTRY -II
(Effective from the admitted batch of 2021-2022)

Course Outcomes (COs)/Course Specific Outcomes (CSOs)

Upon completion of the course the students will be able to,

CO1: Explain the basic concepts of Crystallography.

CO2: Understand the types of polymers and analyze various physical properties of polymers.

CO3: understand the concepts of electrochemistry and theories like Debye Huckel theory

CO4: Understand the basic concept and theories of electrode-electrolyte interface.

CO5: Learn Principles of photochemistry and various photochemical reactions.

Learning Outcomes (LOs):

Upon completion of the course the student will be able

- To determine electrical magnetic properties of solids.
- To analyze the kinetics of different polymerization process.
- To apply the basic concept of electrochemistry to different electrochemical cells.
- To predict the mechanisms of photochemical reactions.

COURSE CONTENT

UNIT-I: **[15 Hours]**

Crystal structure of solids: Fundamental of lattices, unit cell, Bravais lattices, symmetry elements in crystals,packing efficiency, radius ratios; Miller indices. structures and types of solids. Structure determination by X-ray diffraction (Bragg's equation). Magnetic properties of solids- classification of magnetic materials, Magnetic susceptibility, Measurement of magnetic susceptibility. Electric properties-Band theory, the band structure of metals, insulators, and semiconductors.The temperature dependence of the conductivity of extrinsic semiconductors. Superconductivity and occurrence. Meisner effect. Types of superconductors. Theories of superconductivity - BCS theory.

UNIT-II: **[15 Hours]**

Classification of polymers - Free radical, ionic and Zeigler - Natta Polymerization - kinetics of free radical polymerization - Techniques of polymerization - Glass transition temperature - Factors influencing the glass transition temperature - Number average and Weight average, Molecular weights - molecular weights determination - End group analysis - Osmometry - Light scattering and ultra-centrifugation methods.

UNIT-III: **[15 Hours]**

Electrochemistry I: Ionic mobilities and conductivities - Debye-Huckel theory of strong electrolytes, Debye-Huckelonsagar equation-limitations- mean activity coefficient - Verification of Debye-Huckel limiting law.

Electrochemical cell- Galvanic and electrolytic cell. Nernst equation-Concentration cell with and without transference- effect of complexation on redox potential- ferricyanide/ ferrocyanide couple, Iron(III) phenonthroline/ Iron(II) phenonthroline couple. Fuel Cells- construction-Various types-Examples.

UNIT-IV: **[15 Hours]**

Electrochemistry II: The electrode-electrolyte interface. The electrical double layer. The Helmholtz-Perrin parallel-plate model, the Gouy-Chapman diffuse-charge model and the Stern model. Electrodics: Charge transfer reactions at the electrode-electrolyte interface.Derivation of Butler-Volmer equation. High field approximation, Tafel equation, Low field equilibrium, over voltage. Theories of over voltage- Corrosion - Concentration polarization - Polarography -Half wave potential and Ilkovic equation.

UNIT-V: **[15 Hours]**

Photochemistry: Electronic transitions in molecules, Franck-Condon principle. Electronically excited molecules-singlet and triplet states, spin-orbit interaction. Quantum yield and its determination. Actinometry. Derivation of fluorescence and phosphorescence quantum yields. Quenching effect- Stern Volmer equation. Photochemical equilibrium and delayed fluorescence- E-type and P-type. Photochemical primary processes, types of photochemical reactions-photodissociation, addition and isomerization reactions with examples.

Text Books:

1. Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press.

2. Physical Chemistry by G.W. Castellon, Narosha Publishing House

3. Physical chemistry by K.L. Kapoor.

4. Principles of photochemistry, RohitgeeMukhargee.

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SEMESTER-II
PRACTICAL-I: INORGANIC CHEMISTRY
(Effective from the admitted batch of 2021-2022)

Course Objectives:

CO 1:To have hands-on experience/practical knowledge in Inorganic chemistry experiments
CO 2: To develop skills on estimations of analyte by volumetrically
CO 3: To determine analyte by Gravimetrically
CO 4: To study the photochemical reactions

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: To be able to solve problems in analytical chemistry.
LO 2: To extend the idea of determination of analyte by volumetric titration to advanced analytical determinations of various organic and inorganic analytes
LO 3: able to design gravimetric experiments for quantitative estimation of organic and inorganic analytes

COURSE CONTENT

Quantitative analysis:

1.Volumetric methods of Analysis:

i) Determination of Ferric iron by photochemical reduction

ii). Determination of Nickel by EDTA

iii) Determination of Calcium and Magnesium in a mixture by EDTA

iv) Determination of Ferrocyanide by Ceric sulphate

v) Determination of Copper(II) in presence of iron(III)

2.Gravimetric methods of Analysis:

i) Determination of Zinc as Zinc pyrophosphate

ii). Determination of Nickel from a mixture of Copper and Nickel.

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SEMESTER-II

PRACTICAL-II: PHYSICAL CHEMISTRY

(Effective from the admitted batch of 2021-2022)

Course Objectives:

CO 1:To have hands-on experience/practical knowledge in performing Physical chemistry experiments

CO 2: To develop skills on handling instruments like Potentiometry and perform different types of acid-base and redox titrations

CO 3: To determine specific rotations and percentage of to optically active substances by polarimetrically

CO 4: To study the stability of complex ion and stranded free energy change and equilibrium constant by potentiometry

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: To be able to develop/practical skills to solve problems in chemistry.
LO 2: To extend the principle of Potentiometric titration to other kind of reactions.
LO 3: To study the kinetics of reactions and determine the order of reactions.

COURSE CONTENT

1. Potentiometric titration of Iron (II) using potassium dichromate
2. Potentiometric titration of strong acid with a strong base using quinhydrone electrode
3. Determination of kinetics of Ester hydrolysis
4. Determination of Equilibrium constant of Potassium Iodide-Iodine system
5. Determination of kinetics of inversion of cane sugar by polarimetry method.
6. Determination of partial molar volume of solute –H_2O system by apparent molar volume method.

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SEMESTER-II

PRACTICAL-III: ORGANIC CHEMISTRY

(Effective from the admitted batch of 2021-2022)

Course Objectives:

CO 1: To develop an insight into the identification of organic compounds by systematic analysis
CO 2: To understand the process of identification of organic compounds by systematic analysis
CO 3: To acquire skills in the identification of organic compounds by systematic analysis

Learning Outcomes:

At the end of the course, the learners should be able to:
LO 1: Identify an organic compound by systematic analysis
LO 2: Develop skill in identification of organic compounds by systematic analysis
LO 3: Apply the skill in the identification of new organic compounds by systematic analysis

COURSE CONTENT:

Identification of the unknown organic compounds

Systematic identification of organic compounds – preliminary tests, detection of extra elements, solubility, common functional group tests (determination of functional group/s in a single compound, if present), preparation of two rational derivatives

The given organic compound must be identified by comparing the melting point /Boiling point of the compound and melting points of its derivatives with the literature

List of suggested compounds

Glucose, fructose, benzaldehyde, p-anisaldehyde, p-chloro benzaldehyde, acetophenone, phenol, cresols, naphthols, esters, p-chloro benzoic acid, aniline, p-tolune, p-anisidine, p-chloroaniline, diphenyl amine, N,N-dimethylaniline, benzamide, naphthalene and anthracene.

TEXT BOOKS

1. A Textbook of Practical Organic Chemistry by A. I. Vogel, ELBS and Longman group.
2. Practical Organic Chemistry by Mann and Saunders, ELBS and Longman group.

Model Question paper

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION

SEMESTER-II

Paper I: General Chemistry-IISemester-II

(w.e.f. 2021-2022 admitted batch)

Time: 3 Hours **Answer ALL questions Maximum marks: 80 (5X16 =80 marks)**

(1) (a) i) Derive Schrodinger wave equation?

ii) Explain the postulates of Quantum mechanics

Or

(b) i) Write notes on Hermitian operator and its properties

ii) Explain normalization and orthogonalisation

(2) (a) i) Solve the Schrodinger wave equation for a particle in a one-dimensional box.

ii) Write the factors influencing color

Or

(b) i) Derive the Schrodinger wave equation for a simple harmonic oscillator

ii) Describe the concept of tunneling

(3) (a) i) Explain the solutions of R(r), $\theta(\theta)$ and $\Phi(\phi)$ equations of hydrogen atom

ii) Explain probability density in orbitals

Or

(b) i) Explain the time independent perturbation theory to evaluate the ground state energy of helium atom.

ii) Application of above to ground state energy of hydrogen and helium atom

(4) (a) i) What is variation principle. Write its application to calculation of ground state energy of harmonic oscillator.

ii) Compare Perturbation and variation theorems.

Or

(b) i) Explain Hartee-Fock self-consistent field method for multi electron atoms.

ii) Write a note on Density functional theory(DFT)

(5) (a) i) Explain quantum mechanical approach of molecular orbital theory.

ii) Calculate the ionic and covalent bond contributions in hydrogen molecule

Or

(b) i) Discuss the valence bond approach of H_2 molecule.

ii) Write the electronic transitions in the hydrogen molecule.

MODEL QUESTION PAPER

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SEMESTER-II

Paper- II: Inorganic Chemistry-II

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questionsMax. Marks**: 80 **(5x16=80 Marks)**

1. a) (i)Discuss the structure and magnetic property of $Cu_2(RCOO)_4(H_2O)_2$.
(ii)) Write a note on Chevrel phases

OR

(b) (i) Discuss the preparation of, structures of and bonding in $Re_2Cl_8^{2-}$.
(ii) Describe the structures of hexanuclear metal clusters.

2. a) (i)Explain the synthesis, structure and reactions of metal carbonyls.
(ii) Explain Isolobal relationship with suitable examples.

OR

b) (i) Describe the preparation of, structure of and bonding in ferrocene.
(ii) What is 18 electron rules? Illustrate with suitable examples

3. a) (i) Explain the factors affecting the stability of coordination compounds.
(ii) Distinguish between stepwise and overall stability constants.

OR

(b) (i) Describe the Irwing -William's series, Pearson's theory of hard and soft acids and bases (HSAB),
(ii) What is chelate effect and discuss its thermodynamic origin

4. a) (i) Discuss a spectrophotometric method for the determination of binary formation constant of a metal complex.
(ii) What are inert and labile complexes?

OR

(b) (i) Describe the pH – metric method for the determination of stability constants.
(ii) Explain inert and labile complexes by using crystal field stabilization energies?

5. a) (i) What is acid hydrolysis reactions? Discuss Factors affecting acid hydrolysis reactions
(ii)) What is trans effect? Distinguish between the trans effect and trans influence.

OR

b) (i) Give an account of base hydrolysis of Cobalt (III) complexes.
(ii) Discuss the various factors affecting the rates of substitution reactions of octahedral complexes.

MODEL QUESTION PAPER

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SEMESTER-II

Paper- III: Organic Chemistry-II

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questions** **Max. Marks**: **80 (5x16=80 Marks)**

1. a.**(i)**Explain Aromaticity and Anti aromaticity give examples.

   (ii) Write a note on Von- Ritcher rearrangement

   (or)

   b. (i)Describe Aromatic Nucleophilic Substitution reactions give examples.
   (ii) Write a note on Non-benzenoid aromatic compounds and Annulenes.

2 a. (i)Write any two preparations and reactivity of carbocation.

   (ii) Write a note on Stork enamine reaction.

   (or)

   b. (i)Explain carbanion and nitrene

   (ii) Briefly explain Mannich Reaction with applications.

3 a. (i)Explain Pinacol-pinacolone rearrangement give examples.

   (ii) Describe mechanism and applications of Beckmann rearrangement.

   (or)

   b. (i)Discuss about Baeyer-villager rearrangement.

   (ii) Write a note on Favorskii rearrangement.

4 a. (i)Write the Woodward-Fieser rules for conjugated dienes.

   (ii) Explain types of molecular vibrations in Infrared Spectroscopy.

   (or)

   b(i)Describe factors affecting the chemical shift.

   (ii) Give the fragmentation pattern of alcohols.

5 a. (i) Write the synthesis of nicotine

(ii) Explain Merrifield solid phase synthesis.

(or)

b. (i) Write about Primary, secondary and tertiary structures of proteins.
(ii) How do you differentiate RNA and DNA

MODEL QUESTION PAPER

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SEMESTER-II

Paper- IV: PHYSICAL CHEMISTRY-II

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questions** **Max. Marks**: **80 (05x16=80 Marks)**

1. (a) (i)Derive Bragg's equation

(ii) Explain the theories of superconductivity

(or)

(b) (i)Describe the different methods of measurement of magnetic susceptibility.

(ii) Write a brief note on semiconductors.

2. (a) (i)Give the the classification of polymers with examples.

(ii) What are the factors influencing glass transition temperature.

(or)

(b) (i) How is molecular weight of polymers determined by osmometry and light scattering methods.

(ii) Write a brief note on kinetics of free radical polymerization.

3. (a) (i)Explain Debye-Huckel theory of strong electrolytes

(ii) Discuss the effect of complexation on redox potential with examples?

(or)

(b) (i)Derive an expression for EMF of concentration cell without transference.

(ii) Discuss the important features of Debye-Huckel limiting law.

4 (a) (i)Derive Bulter- Volmer equation

(ii) Explain the Stern model for double layer.

(or)

(b) (i)Explain in detail about polarography.

(ii) Discuss important features of Gouy-Chapman diffuse charge model and Helmholtz parallel plate model

5.(a) (i)Derive Stern-Volmer equation

(ii) State and explain Franck-Condon principle

(or)

(b) (i)Define quantum yield and explain its experimental method determination.

(ii) Discuss the mechanism of photo addition and photo isomerization with examples

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SEMESTER-III

Paper-I: **SolidState Chemistry -1**

(Effective from 2021-2022 Admitted batch)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : Students will be expected to gain knowledge on the basic concepts on crystal structures.

CO2 : Students will learn about description of some important crystal structures

CO3 : Students will able to understand about various experimental techniques for crystal structure determination.

CO4 : Students will be expected to acquire knowledge on various Synthesis methods for polycrystalline powders.

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge on crystal structures -close packing, Pauling's electrostatic valance rules

LO 2 : Learn about description of some important crystal structures of AX (NaCl, CsCl and ZnS), AX_2(Cristobalite, Rutile Fluorite), ABX_3 (Perovskite and Ilminite), AB_2X_4 (Spinel normal and inverse)

LO 3: Learn about Non-stoichiometry mode of incorporation, thermodynamic aspects, experimental methods of determining non-stoichiometry, Non-crystalline solids, composite materials

LO 4 : Gain knowledge on Synthesis methods for polycrystalline powders

Learn the Fabrication of thin films by chemical methods- sintering – techniques and mechanism,

LO 5 : Gain knowledge on Introduction to silicates and zeolites. Applications of zeolites in petrochemical industry- isomerization, hydrocracking and hydrodesulfurization.

LO 6 : Learn about Reactivity of solids -Nature of solid state reactions, solid-gas, solid-liquid and solid-solid reactions, Reactions on solid surfaces -Heterogeneous catalysis.

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SEMESTER-III

Paper-I: **SolidState Chemistry -1**

(Effective from 2021-2022 Admitted batch)

UNIT-I: **[15 hours]**

Description of crystal structures -close packing, Pauling's electrostatic valance rules, description of some important crystal structures of AX (NaCl, CsCl and ZnS), AX_2 (Cristobalite, Rutile ,Fluorite), ABX_3 (Perovskite and Ilmenite), AB_2X_4 (Spinel -normal and inverse). Effect of polarization, pressure and temperature, Lattice energy, basic principle and instrumentation of X-Ray diffraction technique,crystal structure determination (cubic system only) by powder X-Ray diffraction technique.

UNIT-II: **[15 hours]**

Crystal symmetry - screw axes, glide planes and space group notation, crystal imperfections-point defects, thermodynamics of Schottky and Frenkel defect formation, dislocations, planar defects, extended defects (Crystallographic shear and stacking faults), Non-stoichiometry, mode of incorporation, thermodynamic aspects, experimental methods of determining non-stoichiometry, Non-Crystalline solids.

UNIT-III: **[15 hours]**

Preparative methods: Synthesis methods for polycrystalline materials – ceramic, precursor, sol-gel, hydrothermal, chemical vapour transport, spray pyrolysis, chemie douche and self propagation methods.

Unit-IV: **[15 hours]**

Techniques of single crystal growth from solution (low temperature and high temperature solution growth, gel growth), melt and vapor (Bridgman, Czochraiski, Varneuili, Floating zone and chemical vapour deposition methods), Fabrication of thin films by chemical methods, sintering – techniques and mechanism.

UNIT -V: **[15 hours]**

Structural transformations in solids and their classifications, Martensitic and order-disorder transformations. Reactivity of solids -Nature of solid state reactions, solid-gas, solid-liquid and solid-solid reactions, Reactions on solid surfaces -Heterogeneous catalysis. Introduction to silicates and zeolites. Applications of zeolites in petrochemical industry-isomerization, hydrocracking and hydrodesulfurization.

Text books:

(1) Solid-state chemistry and its applications by A.R. West, John Wiley &Sons.

(2) Solid-state chemistry -an introduction by Lesley Smart and Elaine Moore Viva books private limited, New Delhi.

(3) Principles of the solid-state by H.V. Keer,Wiley Eastern Ltd.

Reference book:
1. New directions in solid state chemistry By C.N.R. Rao and J. Gopalakrishnan.
2. The Physics and Chemistry of NanoSolids by Frank J. Owens and Charles P. Poole Jr,Wiley-Interscience, 2008.
3.Chemistry of Zeolites and Related Porous Materials: Synthesis and Structure by Ruren Xu Wenqin Pang Jihong Yu QishengHuoJiesheng Chen, 2007
Print ISBN:9780470823333

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SEMESTER-III

Paper – II: Structure, Bonding and Reactivity of coordination compounds – I

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of coordination compounds.

CO2 : To impart knowledge on structural and thermodynamic effects of crystal field splitting

CO3 : To learn and practice about Electronic Spectra and its Selection rules

CO4 : To inculcate basic knowledge in optical activity of complex compounds

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge about Theories of bonding – crystal field theory- structural and thermodynamic effects of crystal field splitting

LO 2 : Learn about John – Teller effect – Octahedral and tetrahedral radii – site selection in spinnels

LO 3: Gain knowledge on Evidence for covalence and the adjusted crystal field or the ligand field Theory

LO 4 : Understand about Strong field configurations - Correlation diagrams.

LO 5 : Gain knowledge on Electronic Spectra -Selection rules -Mechanism of breakdown of selection rules

LO 6 : Learn about band Shapes- Orgel and Tanabe -Sugano diagrams

LO 7 : Gain knowledge on Optical activity of Complexes, Sterochemical notation (d- and l-system, R and S system,. Λ and Δ notation, λ and δ System),

LO 8 : Gain knowledge on Magnetic properties- Magnetic properties of free ions -Spin orbit coupling –t_{2g} and e_g Orbital contribution to the Magnetic Moment.

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
Paper – II: Structure, Bonding and Reactivity of coordination compounds – I

(Effective from 2021-22 admitted batch)

Unit I: **[15 hours]**

Theories of bonding – crystal field theory- structural and thermodynamic effects of crystal field splitting – John – Teller effect – Octahedral and tetrahedral radii – site selection in spinnels - thermodynamic effects of crystal field splitting-hydration, ligation, and lattice energies.

Unit II: **[15 hours]**

Evidence for covalence and the adjusted crystal field or the ligand field Theory -Strong field configurations - Correlation diagrams. Molecular orbital theory applied to octahedral and tetrahedral complexes including ∏ bonding -Angular overlap model.

Unit III: **[15 hours]**

Electronic Spectra -Selection rules -Mechanism of break down of selection rules- band Shapes- Orgel and Tanabe -Sugano diagrams .Ligand field spectra of octahedral and tetrahedral complexes of .first transition series -Calculation of crystal field splitting energy (Δ) and Racah Parameters (B). Charge transfer spectra of complexes -Ligand to metal and melal to ligand type.

Unit IV: **[15 hours]**

Optical activity of Complexes, Sterochemical notation (d- and l- system, R and S system,. Λ and Δ notation, λ and δ System), Optical isomerism in chelate octahedral complexes, Circular dichroism (CD), Optical rotatory dispersion (ORD) – definition, principle of measurement, - Cotton effect – determination of absolute configuration, Applications.

Unit V: **[15 hours]**

Magnetic properties- Magnetic properties of free ions -Spin orbit coupling –t_{2g} and e_g Orbital contribution to the Magnetic Moment, temperature independent para magnetism- Quenching of orbital momentum in complexes, Spin cross over-factors effecting spin cross over: chemical and physical.

Text books :

I. Inorganic Chemistry: Principles, Structure and .Reactivity, James E. Huheey, (4th Edition).

2. Advanced Inarganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley Eastern Pvt., New Delhi (4th Edition).

3. Mechanisms of Inorganic Reactions in Solution D. Benson, McGraw Hill, London, 1968.

4. Inorganic Reaction Mechanisms J.O. Edwards.

5. Fundamentals of Photochemistry, K.K. Rohatgi Mukberjee, Wiley Eastern, New Delhi,

1978.

Reference books : .

I. Mechanisms of' Inorganic Reaction: F. Basalo and R.G. Pearson.

2. Inorganic Chemistry, K.F. Purcell and J.C. Kotz; W.B. Saunders Company, New York, 1977.

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SEMESTER-III

Paper III: Bio-inorganic Chemistry

(Effective from 2021-22 admitted batch)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of Bio – inorganic chemistry.

CO2 : To impart knowledge on Chemistry of biomolecules

CO3 : To learn and practice the different Metallo-enzymes and Metal complexes as oxygen carriers

CO4 : To inculcate basic knowledge in optical activity of complex compounds

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge Structural features of prokaryotic and eukaryotic cells

LO 2 : Learn about Chemistry of biomolecules, general aspects, c carbohydrates, lipids, proteins,

nucleic acids, structures of DNA and RNA.

LO 3: Gain knowledge about Metallo-enzymes, Structure and functions of carboxypeptidase and carbonic Anhydrase.

LO 4 : Understand about Vitamin B_6 structure, its role in transamination and oxidative deamination

LO 5 : Gain knowledge on Metal complexes as oxygen carriers – hemoglobin and myoglobin

LO 6 : Learn about synthetic oxygen carriers – Electron transfer proteins – ferredoxins, cytochromes.

LO 7 : Study about Photosynthesis – light reaction, dark reaction, structural features of chlorophyll.

LO 8 : Gain knowledge on Biological nitrogen fixation – composition and structure of nitrogenase, function of different units of nitrogenase, reaction pathway of nitrogen fixation.

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SEMESTER-III

Paper III: Bio-inorganic Chemistry

(Effective from 2021-22 admitted batch)

UNIT I: **[15 hours]**

Structural features of prokaryotic and eukaryotic cells – Chemistry of biomolecules, general aspects, c carbohydrates, lipids, proteins, nucleic acids, structures of DNA and RNA.

Inorganic elements in biological systems – role of alkali and alkaline earth metal ions in biological systems and their transport across membrane.

UNIT II: **[15 hours]**

Metallo-enzymes, Structure and functions of carboxypeptidase and carbonic Anhydrase. Vitamin B_6 structure, its role in transamination and oxidative deamination, Vitamin B_{12} and B_{12} Co-enzymes, Structure of Vitamin B_{12} -coordination chemistry, Oxidation states of its metal.

UNIT III: **[15 hours]**

Metal complexes as oxygen carriers – hemoglobin and myoglobin, Cooperativity, Bohr effect, non-porphyrin oxygen carriers – hemerythrin and hemocyanin

UNIT IV: **[15 hours]**

Synthetic oxygen carriers – – ferredoxins, cytochromes.

Photosynthesis – light reaction, dark reaction, structural features of chlorophyll, Electron transport chain in light reaction, Z-scheme, role of manganese clusters in water splitting reaction.

UNIT V: **[15 hours]**

Biological nitrogen fixation – composition and structure of nitrogenase, function of different units of nitrogenase, reaction pathway of nitrogen fixation.

Toxicity of metals – Symptoms of metal toxicity, mechanism of metal toxicity, biomethylation, Minamata disease, chemical speciation of arsenic, mercury, Biological defence mechanism, chelating agents in metal ion detoxification.

Metal complexes as drugs and anti cancer agents – anti-arthritic gold drugs, lithium therapy in psychiatric disorders, anti-cancer activity of platinum complexes, mechanism of anti-cancer activity.

Books:

1. Biochemistry by Lehninger (1982)
2. Biochemistry by L. Stryer
3. Inorganic Chemistry of Biological processes by M.N. Hughes
4. Bio-inorganic Chemistry – An introduction by Ei-Ichiro Ochiai, Allyn and Bacon Inc. (1977)
5. Inorganic Biochemistry, Vols I and II by G.L. Eichhorn.
6. Inorganic Chemistry by J. E. Huhey, Harper International
7. Bio-inorganic Chemistry by R.W. Hay, Ellis Harwood Ltd. (1984)
8. Bio-inorganic Chemistry by Asim K. Das, Books and Allied (P) Ltd. (2007)
9. Bio-inorganic Chemistry by Bertini, Gray, Lippard and Valentine, Viva Books Private Ltd. (2007)
10. Elements of bioinorganic Chemistry by G. N. Mukherjee and Arabinda Das, U.N. Dhur & Sons Pvt. Ltd (1993)

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SEMESTER-III
Paper—IV: PHYSICAL METHODS IN INORGANIC CHEMISTRY-I
(Effective from 2021-22 admitted batch)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of various molecular spectroscopic techniques like Vibrational Spectroscopy, UV-Visible Spectroscopy, Photo electron spectroscopy, NMR and ESR.

CO2 : To impart basic and fundamental knowledge of various atomic spectroscopic techniques like Flame Photometry, Atomic Emission Spectroscopy and Inductively coupled plasma emission spectroscopy

CO3 : To impart knowledge on Applications of NMR to Inorganic chemistry

CO4 : To impart basic and fundamental knowledge of various electro analytical techniques

CO 5 : To inculcate basic knowledge on applications of various instrumental methods in inorganic chemistry.

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge spectroscopy, Instrumentation, Quantitative Analysis, FTIR, NIR, MIR, FIR,

LO 2 : Gain knowledge Raman Spectroscopy Principle, Instrumentation and Applications of Raman Spectroscopy

LO 3: Gain knowledge about Flame Photometry: principle nebulizer examples: Na, Alkali and Alkaline earth metals.

LO 4 : Understand about Atomic absorption spectroscopy: Principle, basic instrumentation, resonance line source (Hollow cathode lamp),

LO 5 : Gain knowledge about Inductively coupled plasma emission spectroscopy(ICP-OES): Principle of inductively coupled plasma, advantages with plasma

LO 6 : Acquire knowledge on voltametry – Principle, Instrumentation, applications, diagnosis of coupled chemical reactions.

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SCHOOL OF CHEMISTRY
DEPARTMENT OF INORGANIC & ANALYTICAL CHEMISTRY
SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-III
Paper—IV: PHYSICAL METHODS IN INORGANIC CHEMISTRY-I
(Effective from 2021-22 admitted batch)

UNIT – I: **[15 hours]**

a)Vibrational Spectroscopy: Infrared spectroscopy, Instrumentation, Quantitative Analysis, FTIR, NIR, MIR, FIR, Raman Spectroscopy Principle, Instrumentation and Applications of Raman Spectroscopy

b) UV-Visible Spectroscopy: Principle Instrumentation- Single Beam, Double Beam ,Quantitative determination of – Fe^{3+}, Mn^{2+}, PO_4^{3-}, NO_3^-, NO_2^-, simultaneous determination of Cr(VI) and Mn(VII), Photometric titrations, composition of a complex (Fe^{2+}- orthophenanthroline).

c) Photo electron spectroscopy: Principle, UV PES spectra of HCl, Cl_2, N_2, O_2 and CO, XPES – chemical analysis (ESCA), principle, chemical shift, applications of XPES for study of oxidation states, molecular structure of $Na_2S_2O_3$, N_2O, N_3^-, $Pt(NH_3)_3Cl_3$.

UNIT – II: **[15 hours]**

a) Flame Photometry: principle nebulizer examples: Na , Alkali and Alkaline earth metals.
a) Atomic absorption spectroscopy: Principle, basic instrumentation, resonance line source (Hollow cathode lamp), Interferences, evaluation methods, non-flame techniques, applications, determination of As, Pb, Hg , Al & Cd.
b) Atomic Emission Spectroscopy: Principle of AES, types of flames, spark/arc and applications

Unit-III: **[15 hours]**

Inductively coupled plasma emission spectroscopy(ICP-OES): Principle of inductively coupled plasma, advantages with plasma, detectors, wavelength selection and applications
Inductively coupled plasma Mass spectrometry (ICP-MS): instrumentation, quadrupole mass spectrometers, sample introduction, Analyte atomization and ionization, analysis methods for liquids and solids, interferences, calibration curves, applications in the analysis of trace and toxic metals.

UNIT – IV: **[15 hours]**

a)NMR Spectroscopy: Resonance condition, Chemical Shift, spin-spin splitting, factors affecting the appearance of NMR spectra, Classification of NMR Spectra, (AX, AX_2, AX_3, AMX and AB types) vicinal, geminal coupling, methods to simplify complex spectra, spin decoupling, shift reagents, Introduction to MASNMR and 2-D NMR techniques. Applications of NMR to Inorganic ^1H, ^{19}F, ^{31}P, ^{15}N, ^{11}B ^{13}C (ClF_3, BrF_5, HPF_2, PF_3, SF_4, NH_3, NH^+_4, B_2H_6).
b) ESR Spectroscopy: Principle, Hyperfine splitting, Krammer's degeneracy, applications of ESR of copper acetate, NH_2^*,CH_3^*, CH_2OH^*, Naphthalene anion, copper bis (salicylaldamine), structural elucidation of copper complex through anisotropy in hyperfine coupling constants, study of free radicals, comparison of NMR and ESR techniques.

UNIT V: Electro analytical methods: **[15 hours]**

a)Principle of Voltametry – Polarization of electrode, over voltage, factors affecting over voltage, diffusion current, migration current. DC Polarography, AC Polarography, pulse polarography – normal pulse, differential pulse and square wave polaragraphy. Applications of Polarography, Determination of Cd^{2+} ,Zn^{2+}, Pb^{2+}

b) Principle of stripping analysis – anode stripping voltametry.
c) Cyclic voltametry – Principle, Instrumentation, applications, diagnosis of coupled chemical reactions.
d) Coulometry – Principle, types of coulometry – Potentiostatic and amperostatic, coulometric titrations, Applications.

Books:

1. Instrumental methods of analysis, (6^{th} Edition) Hobart H. Willard, Lynne L Merit Jr. and John A Dean and Frank A Settle, Jr.
2. Vogel's Text Book of Quantitative Chemical analysis,(6^{th} Edition) Basset Re Dnnex, G.H. Jeffery and J.Mendham.
3. Physical methods in Inorganic Chemistry, R.S. Drago.
4. Principles of Instrumental Analysis, Skoog, West and Holler.

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SEMESTER-III
INORGANIC CHEMISTRY PRACTICALS-I (CLASSICAL)

I. Preparation of single crystal from solution and by gel growth

II. Preparation and chemical analysis of the Complexes

1. Mercury tetrathiocyanatocobaltate(III)
2. Hexamminecobalt(III) chloride
3. Potassium tris(oxalato)chromate(III)
4. Potassium tris(oxalato)aluminate(III)

III. Quantitative Analysis

1. Determination of calcium(II) by precipitation from homogeneous solution
2. Determination of copper(II) and nickel(II) in a mixture
3. Determination of calcium and magnesium in a mixture using EDTA (Eg dolomite)
4. Determination of Iron(II) and Iron(III) in a mixture (Eg Iron ore)
5. Determination of Ferrocyanide and Ferricyanide in a mixture
6. Determination of carbonate and bicarbonate in a mixture
7. Determination of Iron(III) and Aluminium(III) in a mixture
8. Determination of sodium(I) using cation exchanger
8. Determination of sodium(I) and potassium(I) in a mixture using cation exchanger
9. Determination of chloride using anion exchanger
10. Analysis of brass
11. Analysis of solder
12. Determination of COD and BOD of water samples

IV. Determination crystal field splitting energy and spectrochemical series for chromium complexes.

References

1. Vogel's Quantitative Inorganic Analysis

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-III
Paper-I: SolidState Chemistry -1
(effective from the 2021-2022 admitted batch)

Time: 3 hours **Max. Marks: 80**

Answer All Questions **16x5= 80 Marks**

1. a) Discuss principle behind powder X-ray diffraction(PXRD).
b) Explain how PXRD can be used in the crystal structure determination of cubic systems.

OR

a) Explain Pualing's electrostatic valance rules with examples
b) Explain structures of normal and inverse Spinels

2.a) What are non-crystalline solids? Explain.
b) Discuss the thermodynamics of Schottky and Frenkel defect formation

OR

a) Describe the non-stoichiometry in solids. What are the various experimental methods used for the determination of non-stoichiometry in solids?
b) Discuss screw axes, glide planes and space group notation of solid crystals.

3. a) Describe ceramic method used for the preparation of polycrystalline solids
b) Describe the synthesis of zeolites using hydrothermal method.

OR

a) What are polycrystalline solids? Explain sol-gel synthesis of polycrystalline solids with examples
b) Describe chemical vapour transport method for the synthesis of polycrystalline solids

4. a) Detail out methods for the growth of single crystals from solutions.
b) Describe Bridgman method for single crystal formation

OR

a) What is sintering? Explain various techniques used for sintering. Also explain the mechanism of sintering.
b) Exaplin Czochraiski method for single crystal formation

5. a) What are zeolites? Explain their strcture.
b) Describe their application of zeolites in petrochemical industry.

OR

a) Describe various structural transformations in solids and explain their classification
b) Explain order-disorder transformations with a example

MODEL QUESTION PAPER

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION

Paper – II: **Structure, Bonding and Reactivity of coordination compounds – I**

(EFFECTIVE FROM 2021-22 ADMITTED BATCH)

Time: 3 hours Max. Marks: 80

ANSWER ALL QUESTIONS 5x16=80 Marks

1. a) Explain theories of bonding with merit and demerits
b) Describe in detail about the evidences available in support of crystal field stabilization energies in transition metal complexes.

OR

a) Discuss about the John – Teller effect with suitable examples.
b) Discuss site selection in spinnels

2.a) Explain Charge transfer spectra in co-ordination complexes
b) Explain why $KMnO_4$ has very intense purple in colour whereas $[Mn(OH)_6]^{2+}$ is pale pink in colour.

Or

a). Explain how MO theory is superior to CF theory in explaining the bonding in octahedral complexes.
b) Discuss the effect of '$\prod$' bonding on the crystal field splitting energy of an octahedral complex according to MO theory.

3.a. a) Explain the d^2 configuration co-ordination complexes using Orgel diagrams
b) Discuss the differences between Orgel diagrams and Tanabe-Sugano diagrams

Or

a. Write notes on i) Racah parameters and ii) Mechanism of breakdown of selection rules.
b) Explain why $KMnO_4$ exhibits intense color ?

4. a) What is Optical rotatory dispersion (ORD)? Describe definition and principle of measurement
b) Discuss ORD application in determination of absolute configuration.

Or

a) Write a note on optical activity of Complexes
b) What is cotton effect? Explain its significance and give its applications.

5.a) Explain spin-orbit coupling in co-ordination complexes. How it effects absorption spectrum?
b) What do you understand by quenching of orbital angular momentum? What are the consequences of such quenching? Explain with suitable examples.

Or

a) Discuss temperature independent para magnetism in complexes
b. Explain the magnetic properties of free transition metal ions? Discuss the anomalies of first row transition metal ions.

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SEMESTER-III

Paper—III: BIO-INORGANIC CHEMISTRY

(Effective from 2021-2022 admitted batch)

Time: 3 hours Max. Marks: 80

ANSWER ALL QUESTIONS **5x16=80 Marks**

1. a) Discuss the role of alkali and alkaline earth metals in transport across the membranes and muscle contraction.
   b) Explain the structures of DNA and RNA

OR

a) Describe the structures of nucleic acids and explain their role in biological systems.
b) Discuss structural features of prokaryotic and eukaryotic cells

2. a) Discuss the structure and the functions Carbonic anhydrase
   b) Explain structure and function of Carboxy peptidase.

OR

a) Give the structure of Vitamin B_{12} and explain its biological functions.
b) What are co-enzymes? Discuss their role with an example

3. a) Discuss the structure Myoglobin
   b) Discuss functions of Myoglobin and Hemoglobin.

OR

b) What are non-porphyrin oxygen carriers? Give examples
b) Discuss structure and function of hemocyanin

. 4. a) What are ferredoxins? discuss their types along with structures
   b) Discuss the role of cytochromes in electron transfer reactions.

OR

a) Discuss the structural features chlorophyll in photosynthesis
b) Explain the role of manganese clusters in water splitting reaction

5. a) What is biological nitrogen fixation? Explain its importance
   b) Discuss the function and structure of nitrogenase in nitrogen fixation

OR

a) Discuss the toxicity and chemical speciation of arsenic and mercury
b) Discuss the application of metal complexes for anti-cancer activity with examples

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SEMESTER-III

PAPER-IV**: PHYSICAL METHODS IN INORGANIC CHEMISTRY-I**

(Effective from 2021-2022 Admitted batch)

Time: 3 hours **Max. Marks: 80**

ANSWER ALL QUE STIONS 5x16=80 Marks

1.a) Explain the working theory and instrumentation of double beam UV-visible spectrophotometry

b) Explain quantitative determination of Mn^{2+}& PO_4^{3-} using UV-visible spectrophotometry

OR

b) a) Explain the principle instrumentation and application of Raman Spectroscopy

b) Explain IR and Raman spectrum of CO_2 molecule.

2. a)) Explain the different flame techniques involved in AAS.

b) Describe various interferences in AAS technique

OR

a) Explain the principle, instrumentation and applications of flame photometry

b) Discuss the differences and similarities between AAS and AES

3. a) What is inductively coupled plasma? Describe the detectors used for ICP-OES technique

b) Discuss the limitations of ICP-OES analysis

OR

a) Describe atomization and ionization process of ICP-MS technique.

b) Write the applications of ICP-MS for trace element detection.

4. a) Describe the NMR spectra of the following compounds for all NMR active nuclei

i) ClF_3, ii) HPF_2 , iii)PF_3, and iv)SF_4

b) Describe AX and AMX type NMR spectra.

Or

a) What is hyperfine splitting in ESR spectroscopy? Explain with suitable examples.

b) Describe the ESR spectrum of copper bis (salicylaldamine)

5. a) Explain principles of DC Polarography, AC Polarography and pulse polarography techniques

b) Describe anode stripping voltammetry principle and write its applications

(or)

a) Describe the instrumentation of dropping mercury electrode.

b) Explain the following (i) Square wave polarography. (ii) Pulse polarography.

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SEMESTER-IV

Paper-I: **Solid State Chemistry -II**

(Effective from 2021-22 Admitted batch)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of solid state chemistry.

CO2 : To impart knowledge on some important crystal structures

CO3 : To learn and practice the different techniques of single crystal growth from solution

CO4 : To inculcate basic knowledge in reactivity of solids

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge on Phase equillibria in solids: One component systems (SiO_2, GeO_2, TiO_2, ZrO_2). Two component systems with eutectic, compound and solid solution formations

LO 2 : Understand about Semiconductors, types of semiconductors, band gap, Fermi level, charge carrier concentration, effective mass, Hall effect,

LO 3: Study about Type-I and Type-II semiconductors, Isotope effect, specific heat, High T_c superconductors, structure of $YBa_2Cu_3O_7$ – Application of superconductors.

LO 4 : Learn the Magnetic properties: Diamagnetism, Paramagnetism, magnetic ordering – ferro, ferri and antiferro. Hard and soft ferrites, ceramic magnets, applications of ferrites.

LO 5 : Learn about Growth kinetics: nucleation and growth processes. Synthesis of metal nanoparticles, metals oxides nanoparticles and semiconductor nanoparticles, preparation of nanorods

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SEMESTER-IV

Paper-I: **Solid State Chemistry -II**

(Effective from 2021-22 Admitted batch)

UNIT-I: **[15 hours]**

Phase equilibria in solids: One component systems(SiO_2, GeO_2, TiO_2, ZrO_2). Two component systems with eutectic, compound and solid solution formations, general considerations of crystal chemistry, Model structures. Three component systems with binary and ternary eutectics- binary compound formation ternary compound formation.

UNIT-II: **[15 hours]**

Free electron theory, Band theory of solids(Kroning Penney Model). Semiconductors, types of semiconductors, compound semiconductors, band gap, thermal excitation, photoexcitation, the Maxwell-Boltzmann distribution, Fermi level, charge carrier concentration, effective mass, Hall effect, Semiconductor devices – rectifiers, transistors and solar cells, photocatalytic applications.

UNIT-III: **[15 hours]**

Fast ion conductors/solid electrolytes, types of solid electrolytes, applications of solid electrolytes-batteries, fuel cells, Sensors, super conductivity Meissner effect, Type-I and Type-II semiconductors, Isotope effect, specific heat, High T_c superconductors, structure of $YBa_2Cu_3O_7$ – Application of superconductors.

UNIT-IV: **[15 hours]**

Magnetic Properties: Diamagnetism, Paramagnetism, Magnetic ordering – ferro, ferri and antiferro. Hard and soft ferrites, ceramic magnets, applications of ferrites. Optical properties: Refractive index, birefringence and crystal class, phosphors and their applications, solid-state lasers and their applications, introduction to non-linear optical materials

Dielectric properties: Mechanisms of polarization, frequency dependence of polarization, dielectric loss, ferrro, piezo and pyroelectric materials – their characteristic properties, symmetry relations and applications, Introduction to liquid crystals

UNIT- V: **[15 hours]**

Introduction to Nanomaterials concept of bulk versus nanomaterials, “Top down’ vs. ‘Bottom up’ approach of synthesis with suitable examples. Growth kinetics: nucleation and growth processes. Synthesis of metal nanoparticles, metals oxides nanoparticles and semiconductor nanoparticles, preparation of nanorods (vapour-liquid-solid growth, electro spinning), fabrication of nano thin films (atomic layer deposition,Langmuir-Blodgett methods), carbon nanotubes, properties of nanomaterials; nanocomposite.

Characterization techniques of nanomaterials(Elementary treatment only)**:** Atomic force microscopy (AFM), Scanning electron microscopy (SEM) and Transmission Electron microscopy (TEM). Applications of nanomaterials with respect to energy, environment and biomedical.

Text books:

1) Solid-state chemistry and its applications by A.R. West John, Wiley& Sons.

2) Solid-state chemistry -an introduction by Lesley Smart and Elaine Moor,

Viva books private limited, New Delhi.

3) Principles of the solid-state by H.U. Keer, Wiley Eastern Ltd.

Reference books

1. New directions in solid-state chemistry By C.N.R. Rao and J. Gopalakrishnan

2. Structure-property relations by R.E. Newnham Springer-Verlag Publications

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SEMESTER-IV
Paper – II: **Structure, Bonding and Reactivity of coordination compounds – II**
(**Effective only for 2020-21 academic year**)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of mechanism of inorganic reactions.

CO2 : To impart knowledge on Homogeneous catalysis

CO3 : To learn and practice about Electronic Spectra and its Selection rules

CO4 : To inculcate basic knowledge on photochemistry

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Learn about -Mechanism of ligand replacement reactions in octahedral complexes - Acid hydrolysis, (acid dependent and independent) anation and base hydrolysis – Reactions without metal - ligand bond cleavage.

LO 2 : Study Mechanism of ligand replacement reactions in square planar complexes - Effect of Nucleophiles.

LO 3: Gain knowledge on Electron transfer reactions of complexes -Inner and outer sphere mechanisms

LO 4 : Gain knowledge on Homogeneous catalysis, Metal ion catalyzed reactions –Redox potentials and processes- Mechanisms of redox processes 'involving ligands

LO 5 : Gain knowledge on Molecular rearrangements -Four coordinated complexes – Isomerization and recemization of six coordinated complexes.

LO 6 : Study about Photochemistry –Pbotophysical processes -Radioactive and non.radioactive processes -internal conversion and Inter system - Crossing Frank - Condon principle.

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SEMESTER-IV

Paper – II: **Structure, Bonding and Reactivity of coordination compounds – II**
(**Effective only for 2020-21 academic year**)

Unit I : **[15 hours]**

Mechanism of inorganic reactions -Substitution reactions of metal complexes -Mechanism of ligand replacement reactions in octahedral complexes -Acid hydrolysis, (acid dependent and independent) anation and base hydrolysis –Reactions without metal - ligand bond cleavage.

Unit II: **[15 hours]**

Mechanism of ligand replacement reactions in square planar complexes - Effect of nucleophiles- Effect of leaving group, effect of solvent. Effect of non-labile group; Trans effect -Mechanism of trans effect -Cis effect, Trans influence.

Unit III: **[15 hours]**

Electron transfer reactions of complexes -Inner and outer sphere mechanisms -Marcus theory, complementary and non-complementary reactions- Discussion of experimental data on the following redox systems. Co(III) -Ce(III); Co(III)-Fe(II) ; TI(III) – Fe(II) ; Tl(III)-Hg (I) and Ce (IV) -Cr(III).

Unit IV: **[15 hours]**

Homogeneous catalysis, Metal ion catalyzed reactions –Redox potentials and processes- Mechanisms of redox processes 'involving ligands - Factors affecting redox potentials – other types of metal catalyzed reactions- Reactions involving Ag (I), Cu(II) and Os(VIII) –Reactions of oxyanions - factors affecting rate, (General discussion only) -Induced reactions -Free radical reactions- Thermal decomposition of peroxy disulphate -Fe(III) – S_2O_8 reactions - chain reactions –H-Br reactions, H_2O_2 –S_2O_8 reactions.

Unit V: **[15 hours]**

Molecular rearrangements -Four coordinated complexes - Isomerization and recemization of six coordinated complexes.

Photochemistry –Pbotophysical processes -Radioactive and non.radioactive processes -internal conversion and Inter system - Crossing Frank -Condon principle

Photochemical reactivity of transition metal complexes -photosubtitution reactions -aquation, anation and ligand exchange photo rearrangement reactions -Geometrical isomerization recemization -linkage isomerization and ligand rearrangement. photo oxidation or reduction -photo decomposition of water.

Text books :

I. Inorganic Chemistry: Principles, Structure and .Reactivity, James E. Huheey.
2. Advanced Inarganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley Eastern Pvt., New Delhi (4th Edition).
3. Mechanisms of Inorganic Reactions in Solution D. Benson, McGraw Hill, 1968.
4. Inorganic Reaction Mechanisms J.O. Edwards.
5. Fundamentals of Photochemistry, K.K. Rohatgi Mukberjee, Wiley Eastern, 1978.

Reference books : .

I. Mechanisms of' Inorganic Reaction: F. Basalo and R.G. Pearson.
2. Inorganic Chemistry, K.F. Purcell and J.C. Kotz; W.B. Saunders Company,1977.

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SEMESTER-IV

Paper III: **Organometallic Chemistry**

(**Effective from 2021-22 admitted batch**)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of Organometallic Chemistry.

CO2 : To impart knowledge on Nomenclature of organometallic compounds.

CO3 : To learn and practice the different Reaction pathways of organometallic compounds

CO4 : To inculcate basic knowledge on applications of organometallic compounds

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge about introduction, 16 electron rule and 18 electron rule, Nomenclature of organometallic compounds

LO 2 : Learn about Cyclic π donors: Synthesis, structure, bonding and reactions of cyclobutadiene, cyclopentadienyl (metallocenes) and benzenoid (dibenzene) complexes.

LO 3: Gain knowledge on Reaction pathways of organometallic compound Associative reactions-Lewis acidity, Lewis basicity and ligand protonation.

LO 4 : Study about the olefin oxygenation (Wacker process or Smidt reaction), olefin hydroformylation (Oxo process), carbonylation reactions, olefin polymerization (Ziegler-Natta catalysis)

LO 5 : Learn about Synthetic applications of organo-lithium,-magnesium, and-aluminum compounds

LO 6 : Gain knowledge about Biological applications of organometallic compounds in medicine, agriculture and horticulture.

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SEMESTER-IV

Paper III: **Organometallic Chemistry**

(**Effective from 2021-22 admitted batch**)

UNIT-I: **[15 hours]**

Introduction, 16 electron rule and 18 electron rule, Nomenclature of organometallic compounds.

Synthesis, structure, bonding and reactions of metal alkyls and metal aryls, Factors affecting stability of metal alkyls and aryls.

Synthesis, structure, bonding and reactions of metal carbonyls, carbonylate anions, carbonyl hydrides and carbonyl halides. Role of IR and Mossbauer in structure elucidation of metal carbonyls, structures of polynuclear metal carbonyls.

Dinitrogen, cyanide, isocyanide and nitric oxide complexes.

UNIT-II: **[15 hours]**

Carbon π donors : Synthesis, structure, bonding and reactions of complexes of olefin, alkyne, allyl and diene complexes, Double σ bonding model, Dewar-Chatt-Duncanson Model.

Cyclic π donors: Synthesis, structure, bonding and reactions of cyclobutadiene, cyclopentadienyl (metallocenes) and benzenoid (dibenzene) complexes.

UNIT III: **[15 hours]**

Reaction pathways of organometallic compounds Associative reactions-Lewis acidity, Lewis basicity and ligand protonation.

Substitution reactions-Nucleophilic ligand substitution, electrophlic and nucleophilic attack on coordinated ligands.

Addition reactions -1,1-addition,1,2-adition, and oxidative addition.

Elimination reactions – 1,2-elimination, binuclear elimination and reductive elimination. Rearrangement reactions - Redistribution reaction and fluxional isomerism.

UNIT IV: **[15 hours]**

Applications of organometallic compounds

Catalytic application - Fischer-Tropsch Synthesis, olefin hydrogenation (Wilkinson catalyst), olefin oxygenation (Wacker process or Smidt reaction), olefin hydroformylation (Oxo process), carbonylation reactions, olefin polymerization (Ziegler-Natta catalysis)

Unit –V: **[15 hours]**

Synthetic applications of organo-lithium,-magnesium, and-aluminum compounds

Biological applications of organometallic compounds in medicine, agriculture and horticulture.

Books:

1. Advanced Inorganic Chemistry by F.A. Cotton and R.G.Wilkinson, Wiley Publications.
2. Inorganic Chemistry by J.E. Huhey, Harper International.

3. Organometallic Chemistry-A unified approach by A.Singh and R.C.Mehrotra, Wiley Eastern Ltd.

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SEMESTER-IV

Paper—IV: **PHYSICAL METHODS IN INORGANIC CHEMISTRY-II**

(**Effective only for 2020-21 academic year**)

Course Objectives

Upon completion of the course the students will be able to,

CO1 : To impart basic and fundamental knowledge of various spectroscopic techniques like Mossbauer Spectroscopy and Mass Spectrometry.

CO2 : To impart basic and fundamental knowledge on magnetic susceptibility, Thermal methods of analysis and radiochemical methods of analysis

CO3 : To impart basic and fundamental knowledge on different chromatographic techniques

CO4 : To impart knowledge on principle and applications of ion selectometry

CO 5 : To inculcate basic knowledge on applications of various instrumental methods in inorganic chemistry.

Learning Outcomes (LOs):

Upon completion of the course the student will be able

LO 1 : Gain knowledge about Mossbauer Spectroscopy: Mossbauer effect, isomer shift, Quadruple splitting, differentiation of cis- and trans- MA_4B_2 type complexes, structural elucidation of Fe compounds – $Fe(CO)_5$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$

LO 2 : Learn about applications of DTA, TG and DTA of $CaC_2O_4.H_2O$, Cu_2S, $CuSO_4.5H_2O$, Differential scanning calorimetry – Principle and applications.

LO 3: Study about carbon dating, preservation of food materials and surgical items using radioactive radiations.

LO 4 : Learn the principle, types of ion selective electrodes - solid membrane, glass, liquid membrane and enzyme based electrodes.

LO 5 : Acquire knowledge on Thin layer chromatography, variation in development techniques, advantages of TLC over paper chromatography.

LO 6 : Learn about Gas chromatography – Principle, basic instrumentation, types of detectors, applications, Hyphenated technique GC-MS.

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SEMESTER-IV

Paper—IV: **PHYSICAL METHODS IN INORGANIC CHEMISTRY-II**

(**Effective only for 2021-22 academic year**)

UNIT I: **[15 hours]**

a) Mossbauer Spectroscopy: Mossbauer effect, isomer shift, Quadrupole splitting, differentiation of cis- and trans- MA_4B_2 type complexes, structural elucidation of Fe compounds – $Fe(CO)_5$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$.

b) Mass Spectrometry: Principle, basic instrumentation, Ionization methods (electron impact, photo ionization, chemical ionization, fast atom bombardment, MALDI), mass analyzers (magnetic, electrostatic, quadrupole and time of flight), energetic of ion formation, types of peaks, resolution, fingerprint applications.

C) Magnetic susceptibility: Experimental methods for the determination of the magnetic susceptibility and magnetic moments- importance to inorganic compounds- VSM, SQID.

Unit II: **[15 hours]**

a) Thermal methods of analysis: Thermogravimetry, factors affecting TG, applications of thermogravimetry, Differential thermal analysis (DTA), applications of DTA, TG and DTA of $CaC_2O_4.H_2O$, Cu_2S, $CuSO_4.5H_2O$, Differential scanning calorimetry – Principle and applications.

Unit-III: **[15 hours]**

Radiochemical methods: Measurement of Radioactivity, Ionization detectors-gas ionization(Ionization chamber, Proportional counter, Geiger –Muller counter) and solid ionization, scintillation detectors, Activation analysis, Isotope dilution analysis. Tracer techniques in analytical chemistry, carbon dating, preservation of food materials and surgical items using radioactive radiations.

Unit IV: **[15 hours]**

a)Ion Selectometry: Basic principle, types of ion selective electrodes - solid membrane, glass, liquid membrane and enzyme based electrodes, gas sensing electrodes, applications – determination of fluoride in water.

b)Separation methods: Solvent extraction- ion exchange, molecular sieving-chromatography.

Unit V: **[15 hours]**

Chromatography: Classification of chromatographic techniques, methods of development, paper chromatography (1D, 2D and multi dimensional), Thin layer chromatography, variation in development techniques, advantages of TLC over paper chromatography, Gas chromatography – Principle, basic instrumentation, types of detectors, applications, Hyphenated technique GC-MS. High performance liquid chromatography (HPLC) – Instrumentation, pre-concentration procedures for HPLC, Van Demeter equation, comparison of HPLC and GC, applications of HPLC.

Books:

1. Instrumental methods of analysis, (6^{th} Edition) Hobart H. Willard, Lynne L Merit Jr. and John A Dean and Frank A Settle, Jr.
2. Vogel's Text Book of Quantitative Chemical analysis,(6^{th} Edition) Basset Re Dnnex, G.H. Jeffery and J.Mendham.
3. Physical methods in Inorganic Chemistry, R.S. Drago.
4. Principles of Instrumental Analysis, Skoog, West and Holler.

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SYLLABUS FOR M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-IV
INORGANIC CHEMISTRY PRACTICALS-II (INSTRUMENTATION)

I. pH metry

1. Determination of concentration of strong acid using strong base
2. Determination of concentration of weak acid using strong base
3. Determination of concentration of weak base using strong acid
4. Determination of concentration of polybasic acid using strong base
5. Determination of stability constant of copper glycinate
6. Determination of dissociation constant of an indicator

II. Conductometry

1. Determination of concentration of strong acid using strong base
2. Determination of concentration of sodium carbonate using strong acid
3. Determination of concentration of weak acid using strong base
4. Determination of concentrations of weak and strong acids in a mixture using strong base
5. Determination of barium
6. Determination of lead
7. Determination of sulfate

III. Potentiometry

1. Determination of Iron(II) using potassium permanganate
2. Determination of Iron(II) using sodium vanadate
3. Determination of Iron(II) using Ceric sulphate
4. Determination of Iron(II) and vanadate in a mixture using potassium permanganate
5. Determination of potassium permanganate and vanadate in a mixture using Iron(II)
6. Determination of ceric sulfate and sodium vanadate in a mixture using Iron(II)

IV. Colorimetry

1. Determination of concentration of Iron(III) using potassium thiocyanate
2. Determination of concentration of Manganese(II) using potassium periodate
3. Determination of Phosphate using molybdate
4. Determination of nitrite by using diazotization method
5. Photometric titration of Copper(II) using EDTA
6. Determination of composition of Iron(II) and 1,10-phenanthroline using Job's method and mole-ratio method
7. Simultaneous determination of chromium(VI) and manganese(VII) in a mixture

V. Electrogravimetry

1. Determination of Copper(II) in a solution

VI. Flame photometry

1. Determination of sodium, potassium and calcium

VII. Thermogravimetry

1. TGA and DTA of calcium oxalate of alkaline earth metals

References:

1. Vogel's Quantitative Inorganic Analysis

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SEMESTER-IV
Paper-I: SolidState Chemistry -II
(effective from the 2021-2022 admitted batch)

Time: 3 hours **Max. Marks: 80**

SECTION-A

Answer All Questions 16x5= 80 Marks

1. a) Discuss phase diagrams of three component systems with binary eutectics
   b) Discuss the phase diagram of SiO_2

OR

a) What are Solid solutions? Describe the phase diagrams of two component systems with solid-solutions
b) Discuss the phase diagram of GeO_2

2. a) Explain electronic conductivity in semiconductors. Describe Fermi level position in various types of semiconductors.
b) Explain hall effect with an example

OR

a) Discuss Kronning penny model used for describing band theory of solids.
b) Describe effective mass in semiconductors

3. a) What is superconductivity? Explain the mechanism behind super conductivity.
b) Explain type-I and type-II superconductors.

OR

a) What are fast ion conductors? Explain their applications
b) Discuss high temperature superconductors

4. a) Explain hard and soft ferrites
b) Describe the properties of pyroelectric materials

OR

b) What are the characteristics of piezo electric materials? Explain their applications

5. a) Discuss in detail “Top down” and “Bottom up” approaches for the synthesis of nanomaterials
b) Discuss vapour-liquid-solid growth method used for the synthesis of nanorods

OR

a) Atomic layer deposition and Langmuir-Blodgett methods for the synthesis of nano thinfilms
b) Describe transmission electron microscopy technique used for characterization of nanomaterials.

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SEMESTER-IV
Paper – II: Structure, Bonding and Reactivity of coordination compounds – I
(Effective from 2021-22 admitted batch)

Time: 3 hours Max. Marks 80

Answer all questions **5x16 = 80 Marks**

1. a. In detail discuss the mechanism of Acid hydrolysis in octahedral complexes
b. Discuss anation reactions with examples
.

Or

a. Discuss the possible mechanisms for the base hydrolysis of coordination compounds citing evidences for the same.
b. Discuss substitution reactions without metal - ligand bond cleavage

2. a. Describe effect of nucleophiles and leaving group on substitution reactions in square planar complexes
b. Describe the role played by solvents on substitution reactions in square planar complexes.

Or

a. Explain Cis- and trans-effects observed in square planar complex. Also detail out the mechanisms.

b. Distinguish between the trans influence and the trans effect. Give at least two examples showing how you can detect the presence of the trans influence in a complex

3. a. With appropriate examples for discussing the outer sphere and inner sphere mechanisms
for electron transfer reactions.
b. Discuss Marcus theory in detail

Or

a. What do you understand by complimentary and non-complimentary reactions.
b. Discuss Co(III) -Ce(III) redox system

4. a. Describe induced reactions with examples
b. Discuss Ag (I) and Cu(II) catalyzed reactions.

Or

a. Write the factors that affect redox potentials of metals
b. Discuss inorganic chain reactions with two examples.

5. a. Explain the non.radioactive photo physical processes
b. Discuss Frank -Condon principle

Or

a. Explain aquation, anation and ligand exchange photo rearrangement reactions
b. Discuss photo decomposition of water

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SEMESTER-IV

Paper—III: ORGANOMETALLIC CHEMISTRY

(Effective from 2021—2022 admitted batch)

Time: 3 Hours **Maximum marks: 80**

5x16 = 80 marks

Answer ALL questions.

1. a) Discuss the synthesis, structure and bonding features of carbonyl complexes
   b) Write a note on dinitrogen complexes

OR

a) Explain the application of IR and Mossbauer spectroscopy techniques in the structural elucidation of metal carbonyls.
b) Discuss 18 electron rule with examples

2. a) Discuss synthesis, structure, bonding and reactions of complexes of olefin.
   b) Discuss Dewar-Chatt-Duncanson model with an example.

OR

a) How is ferrocene synthesized? Explain the molecular orbital treatment of bonding in ferrocene
b) Discuss structure and bonding in benzenoid complexes

3. a) Write a detailed account of oxidative addition reactions
   b) Write a detailed account of elimination reactions

OR

a) Explain the concept of Lewis acidity and Lewis basiscity with respect to organometalics.
b) Discuss fluxional isomerism observed in organometallic complexes

4. a) Discuss olefin hydrogenation using Wilkinson catalyst.
   b) Discuss the catalytic cycle involved in Wacker process

OR

a) Explain olefin polymerization reaction over Ziegler-Natta catalyst
b) Write an account on Fischer-Tropsch Synthesis

5. a) Describe synthetic applications of organo-lithium compounds
   b) Discuss synthetic applications of aluminum compounds

OR

a) Discuss biological applications of organometallic compounds in agriculture
b) Discuss use of organometallic compound in the area of medicine.

MODEL QUESTION PAPER

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SEMESTER-IV

PAPER-IV**: PHYSICAL METHODS IN INORGANIC CHEMISTRY-II**

(Effective from 2021-2022 Admitted batch)

Time: 3 h **Total Marks = 80 M**

Answer all questions 5 x 16M = 80 M

1. a) describe the principle of Mossbauer spectroscopy and explain isomer shift
b) Discuss the structural elucidation of iron carbonyls using Mossbauer spectroscopy

OR

a) Explain various ionization techniques used in massspectrometry including merits and demerits.
b) Describe finger print applications of massspectrometry

2. a) State the principle and explain the instrumentation of DTA and its applications
b) Discuss various factors that effect TGA curves.

OR

a) Discuss the aplications of DSC
b) Discuss the differences between DTA and DSC

3) a) Describe the principle and working of Geiger-Muller counter used for the detection of radioactive radiation
b) Discuss Solid ionization detectors used for the detection of radioactive radiation

OR

a) Explain preservation of food materials and surgical items using radioactive radiations.
b) Discuss carbon-dating technique and its applications

4) a) What are the ion selective electrodes . Explain the working of solid membrane electrode.
b) Discuss principle and applications of gas sensing electrode.

OR

a) What are ion exchangers? Discuss working principle of ion exchange chromatography
b) What are molecular sieves? Discuss working principle of exclusion chromatography

5.a) Explain the principle and Instrumentation of Gas Chromatography. Discuss about various types of detectors.
b) Discuss the applications of gas chromatography

OR

a) Explain the principle and instrumentation of HPLC
b) Discuss the principle and applications of TLC chromatography.