ANDHRA UNIVERSITY

DEPARTMENT OF CHEMISTRY

PROGRAM : M.SC ANALYTICAL CHEMISTRY

REGULATION AND SYLLABUS

EFFECTIVE FROM 2021-2022 BATCH

ANDHRA UNIVERSITY

SCHOOL OF CHEMISTRY

Revised Syllabus for M.Sc. CHEMISTRY (PREVIOUS)

With ANALYTCAL CHEMISTRY SPECIALIZATION

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

Programme Objectives

1. To mould a generation of youth which can apply the subject knowledge in their life and careers
2. To inculcate scientific attitude enriched with a multidisciplinary perspective in the students.
3. To demonstrate broad knowledge of descriptive Chemistry.
4. To impart the basic analytical and technical skills to work effectively in the various fields of chemistry.
5. 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.
6. To demonstrate an ability to conduct experiments in the above sub-disciplines with mastery of appropriate techniques and proficiency using core chemical instrumentation and modeling methods.
7. To demonstrate the ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.
8. 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 Analytical 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 and application of current chemical and scientific theories in Inorganic, Organic, Physical and Analytical Chemistry.

PO3: Be versatile in classical laboratory techniques, use instrumental methods for analysis as well as synthesis and follow standardised 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 Analytical Chemistry

PSO1:- Provide theoretical background and develop practical skills for analysing 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.

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. ANALYTICAL 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-351	Physical Chemistry Laboratory-I1	Practical	06	15	60	75	3 hrs	03
PR-352	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
SCAS313	Paper-I: Separation Methods-I	Theory	4	80	20	100	3 hours	4
SCAS309	Paper-II: Quality Control and Traditional Methods of Analysis-I	Theory	4	80	20	100	3 hours	4
SCAS310	Paper-III: Applied Analysis-I	Theory	4	80	20	100	3 hours	4
SCAS311	Paper-IV: Instrumental Methods of Analysis-I	Theory	4	80	20	100	3 hours	4
PR-353	Practical - I: Classical Methods of Analysis	Lab	3	80	20	100	6 hours	4
PR-353	Practical - II: Instrumental Methods of Analysis	Lab	3	80	20	100	6 hours	4
		Total:				600		24

Non Credit Courses:

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

SEMESTER-IV

Course Code	Course Title	Course Type	Instruction Periods per week	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
SCAS412	Paper-I: Separation Methods-II	Theory	4	80	20	100	3 hours	4
SCAS408	Paper-II: Quality Control and Traditional Methods of Analysis-II	Theory	4	80	20	100	3 hours	4
SCAS409	Paper-III: Applied Analysis-II	Theory	4	80	20	100	3 hours	4
SCAS413	Paper-IV: Instrumental Methods of Analysis-II	Theory	4	80	20	100	3 hours	4
PW-A83	Project Work	Lab	-	100	-	100	-	4
PR-354	Practical - I: Classical Methods of Analysis	Lab	3	80	20	100	6 hours	4
PR-354	Practical - II: Instrumental Methods of Analysis	Lab	3	80	20	100	6 hours	4
VV-701	Viva-Voce		-	-	-	-	-	2
		Total:				700		30

Non Credit Courses:

PR-A1328	MOOCs Course		-	-	-	-	-	2
	Add-on Course on "Research Methodology"		-	-	-	-	-	2

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY

Syllabus for M.Sc. Analytical 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.

COURSE CONTENT

UNIT – I **[12 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 **[12 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 **[12 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 **[12 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 **[12 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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY

Syllabus for M.Sc. Analytical 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: Acquire the knowledge on 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 the knowledge and understanding of Understand the Orgel and Tanabe-Sugano diagrams for d^1 –d^9 octahedral and tetrahedral transition metal complexes of 3d series to newly prepared metal complexes
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: Explain idea of structure and bonding theories of inorganic compounds
LO 2: Interpret Walsh 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 covalence 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

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

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

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

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 inter electronic and spectral parameters for d^8 metal complexes.

UNIT- V

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)

ANDHRA UNIVERSITY

SCHOOL OF CHEMISTRY

Syllabus for M.Sc. Analytical Chemistry Specialization

SEMESTER-I

PAPER-III: ORGANICCHEMISTRY-I

(Effective from the admitted batch of 2021-2022)

Course Objectives: To make the students

CO 1 : Acquire the knowledge of aliphatic nucleophilic, aliphatic electrophilic, 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 compounds and chemistry of natural products

CO3 : Apply theknowledgeandunderstandingofaliphaticnucleophilic,aliphaticelectrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products to new situations

CO4 : Develop interest in the areas of aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

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

LO1 : Explain aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

LO2 : Interpret aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

LO3 : Compare aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

LO4 : Analyse aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

LO5 : Solve aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformational analysis, chemistry of heterocyclic compounds and chemistry of natural products

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

LO7 : Apply aliphatic nucleophilic, aliphatic electrophilic, stereochemistry and conformation alanalysis, chemistry of heterocyclic compounds and chemistry of natural products

COURSE CONTENT

UNIT–I

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 substitution reactions. Sigma, Pi bond participation in acylic and bicyclic systems (Non- classic carbocations). Nucleophilic Substiłutional allylic,Łrigonal and Vinylic carbons. Effect of substrate, attacking nucleophile, leaving group and reaction medium.

UNIT-II

Aliphatic Electrophilic Substitutions: 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, sulphoxides and sulphones.

UNIT-III

Stereochemistry and Conformational Analysis: Optical Isomerism:FtiCal activity, molecular dissymmetry and chirality- elements of symmetry. Fisher's projection D,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, properties of geometricalisomers. Conformation alanalysis: Conformationsofacyclicmolecules-alkanesandsubstitutedalkanes-compoundshavingintramolecularhydrogenbonding. Conformations of cyclohexane, mono and disubstituted cyclohexanes and decalins, effect of conformations on reactivity.

UNIT—IV

Chemistry of Heterocyclic Compounds :Structure, reactivity and synthesis of threemembered Heterocycles: (a) Oxirane: Sharpless method, Shi epoxidation, Jacobsen epoxidation, 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, Industrial Method, 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, and Madelung synthesis (b)Quinoline and Isoquinoline, (c)Coumarins and Chromones.

UNIT—V

ChemistryofNaturalProducts:

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

Steroids:-Nomenclature of steroids, structure elucidation, synthesis and stereochemistry of cholesterol and progesterone

Lipids:-Classification, properties and function-freefattyacids, triglycerides, phospholipids, glycolipids &waxesconjugatedlipids-lipoproteins

Reference Books

1. Advanced Organic Chemistry: Reactions Mechanisms and Structure by Jerry March, Mc.Graw Hill and Kogakush.

2. Organic Chemistry Vol.I(Sixth Ed.)and Vol.II(FifthEd.) by ILFinarELBS.

3. Organic Chemistry (fifthEd.,)by Morrison and Boyd, PHI, India.

4. Organic Chemistry (fifth edition)by Francis A.Carey Tata McGraw Hill publishing Company Limited, New Delhi.

5. StereochemistryofOrganiccompoundsbyErnestL.E1ie1,Samuel H.Wilen

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

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
Syllabus for M.Sc. Analytical 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

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

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

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

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

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

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
Syllabus for M.Sc. Analytical 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 Tetraammine Copper(II) sulphate monohydrate
   (ii) Potassium tris-oxalatoferrate (III) trihydrate
   (iii) Tris-thiourea copper(I) sulphate
2. **Systematic Semimicro Qualitative Analysis of Inorganic six radical mixtures**
   In systematic Semi micro qualitative inorganic analysis, inorganic mixture contains three 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)

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY

Syllabus for M.Sc. Analytical Chemistry Specialization

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

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
Syllabus for M.Sc. Analytical Chemistry Specialization
SEMESTER-I
PRACTICAL-III: ORGANICCHEMISTRY LABORATORY-I
(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

Syllabus for M.Sc. Analytical Chemistry Specialization

SEMESTER-I

Paper- I: GENERAL CHEMISTRY-I

(Effective from 2021-2022 admitted batch)

Time: 3 hours **Answer ALL questions Max. 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

Syllabus for M.Sc. Analytical Chemistry Specialization

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 poly acids.
   (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 bipyramidal geometries.
   (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

Syllabus for M.Sc. Analytical 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

Syllabus for M.Sc. Analytical Chemistry Specialization

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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
Syllabus for M.Sc. Analytical Chemistry Specialization
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)

School of Chemistry
Andhra University
Syllabus for M.Sc. Analytical Chemistry Specialization
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.

School of Chemistry
Andhra University
Syllabus for M.Sc. Analytical Chemistry Specialization
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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
Syllabus for M.Sc. Analytical Chemistry Specialization
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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
Syllabus for M.Sc. Analytical Chemistry Specialization
SEMESTER-II
PAPER-III: ORGANICCHEMISTRY-II
(Effective from the admitted batch of 2021-2022)

Course Objectives: To make the students

CO1: Acquire the knowledge of aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

CO2: Understand aromaticity, aromatic nucleophilic substitution, reactive intermediatesand name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

CO3: 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

CO4: Develop interest in the areas of aromaticity, aromatic nucleophilic substitution,reactiveintermediatesandnamereactions,molecularrearrangements,spectroscopy,alkaloids,peptides,proteinsandnucleic acids

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

LO1: Acquire the knowledge of aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

LO2: Explain aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins andnucleic acids

LO3: Interpret aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

LO4: Compare aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

LO5: Analyse aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

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

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

LO8: Apply aromaticity, aromatic nucleophilic substitution, reactive intermediates and name reactions, molecular rearrangements, spectroscopy, alkaloids, peptides, proteins and nucleic acids

COURSE CONTENT:

UNIT-I: Aromaticity

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

B) **Aromatic Nucleophilic Substitutions:** The SNAr, SN1, benzyne and SRN1 mechanisms. **Reactivity:**Effect of substrate, leaving group and attacking nucleophile. TheVon-Richter,Somm1et-HauserandSmilesrearrangements.

UNIT-II: Reactive Intermediates and Name Reactions

A) **Reactive Intermediates:** Generation, structure, stability and reactivity of Reactive intermediates: carbanion, carbocation, freeradicals, carbenes and nitrenes.

B) **Name Reactions:**- Wittigreaction, Grignardreaction, Storkenaminereaction, Michael addition, Mannich Reaction, Diel's-Alder reaction and Ene-reaction,

UNIT-III: Molecular Rearrangements

Molecular **Rearrangements:**

Types of molecular rearrangements, migratory aptitude;

Rearrangements to electron deficient carbon: Pinacol-pinacolone, Wagner-Meerwein and Benzil-Benzilicacid,

Rearrangements toelectron deficientnitrogen: Beckmann, Hofmann, Curtius, Schmidt and Lossen rearrangements;

Rearrangements to electron deficient oxygen: Baeyer-villiger, Dakin rearrangements;

Other rearrangements: Neber rearrangement and Favorskii rearrangements

UNIT-IV: Spectroscopy

A) UV **Spectroscopy:** Various electronic transitions, selection rules, effect of solvent onelectronic transitions, the absorption laws, chromophores, auxochromes, bathochromicandhypso chromic shifts, hyperchromicand hypochromic effects, Woodward-Fieser rules for conjugated dienes and carbonyl compounds.

B) **Infrared Spectroscopy:** Basic principles: types of molecular vibrations, fingerprint region and identification of functional groups.

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

D) Mass **Spectroscopy:** Basic principles, nitrogen rule and fragmentation pattern of carbonyl compounds and alcohols

UNIT—V: **Alkaloids,Peptides,ProteinsandNucleicacids**

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
SCHOOL OF CHEMISTRY
M.Sc CHEMISTRY (PREVIOUS) SYLLABUS 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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
M.Sc CHEMISTRY (PREVIOUS) SYLLABUS SEMESTER-II
PAPER: INORGANIC CHEMISTRY PRACTICALS -II
(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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
M.Sc CHEMISTRY (PREVIOUS) SYLLABUS SEMESTER-II
PAPER: PHYSICAL CHEMISTRY PRACTICALS -II
(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.

ANDHRA UNIVERSITY
SCHOOL OF CHEMISTRY
M.Sc CHEMISTRY (PREVIOUS) SYLLABUS SEMESTER-II
PAPER: ORGANIC CHEMISTRY PRACTICALS -II
(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
Andhra University, School of Chemistry
M.Sc. Chemistry (Previous) Paper I: General Chemistry-IISemester-II
(w.e.f. 2021-2022 admitted batch)
Time: 3 Hours Answer ALL questionsMaximum 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

ANDHRA UNIVERSITY SCHOOL OF CHEMISTRY

M.Sc. Chemistry (Previous)Paper- II: Inorganic Chemistry-IISemester-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

ANDHRA UNIVERSITY SCHOOL OF CHEMISTRY

M.Sc. Chemistry (Previous) Paper- III: Organic Chemistry-II Semester -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.

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

ANDHRA UNIVERSITY SCHOOL OF CHEMISTRY

M.Sc. Chemistry (Previous) Paper- IV: PHYSICAL CHEMISTRY-II Semester -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

M.Sc., Chemistry **Analytical Chemistry** Specialization

SEMESTER –III Syllabus

Paper - I: **Separation Methods – I**

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

Course Objectives:

CO1 : To impart basic and fundamental knowledge of separation methods.

CO2: To impart knowledge on some important separation techniques and methods.

CO3: To learn and practice the different techniques of chromatography

CO4: To inculcate basic knowledge in modern separation techniques like GC, GC-MS.

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

LO 1 : Gain knowledge classification of different chromatographic methods, methods of development-Elution development, Gradient elution development, displacement development, and frontal analysis.

LO 2 : Study about Dynamics of chromatography-efficiency of chromatographic column, zone spreading, High Equivalent Theoretical Plate (HETP),

LO 3 : Understand the High Performance Thin layer chromatography (HPTLC): principle, technique, and applications.

LO 4 : Gain knowledge on principles, general aspects, adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes,

LO 5 : Learn the principles, properties of xerogels, apparatus and detectors, resolution of gel type, applications to organic compounds.

LO 6 : Learn about Principle, Details of the Instrument, Applications to Inorganic and Organic compounds.

LO 7 : Learn about programmed temperature gas chromatography; applications in the analysis of gases, petroleum products etc., other detectors used their Principles and Applications.

LO 8 : Study about Instrumentation – GC – MS interface – Mass spectrometer (MS) Instrument operation

M.Sc., Chemistry **Analytical Chemistry** Specialization
SEMESTER –III Syllabus
Paper - I: **Separation Methods – I**
(With effect from the admitted batch of 2021-2022 Academic Year)

Unit – I Chromatography - 1

Chromatography:classification of different chromatographic methods, methods of development-Elution development, Gradient elution development, displacement development, and frontal analysis.
Principles of chromatography, different migration, adsorption phenomena, partition, adsorption coefficient, retardation factor, retention time and volume, column capacity, temperature effects, partition isotherm.

Unit – II Chromatography – 2

a. Dynamics of chromatography-efficiency of chromatographic column, zone spreading, High Equivalent Theoretical Plate (HETP), Van Demeter equation, resolution, choice of column, length and flow velocity, qualitative and quantitative analysis.
b. **Paperchromatography:**principle, papers as a chromatographic medium, modified papers, solvent systems, mechanism of paper chromatography, experimental technique, different development methods-ascending, descending, horizontal, circular spreading, multiple development, two dimensional development, reverse phase paper chromatographic technique-visualization and evaluation of chromatograms, applications.

Unit - III Chromatography – 3

a. **Thin layer chromatography*:*** principle, chromatographic media-coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, types of development, visualization methods, documentation, and applications in the separation
b. **High Performance Thin layer chromatography (HPTLC**): principle, technique, and applications.
c. **Column chromatography (adsorption chromatography)*:*** principles, general aspects, adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications.

Unit – IV Chromatography – 4

a. Gel Exclusion chromatography or Gel filtration chromatography*:* principles, properties of xerogels, apparatus and detectors, resolution of gel type, applications to organic compounds.
b. Capillary Electrophoresis: Principle, Details of the Instrument, Applications to Inorganic and Organic compounds.
c. Inorganic molecular sieves:structure of zeolites, crystals, types of sieves, application in the separation of gases including hydrocarbons, ion exclusion-principles and applications,

Unit – V Chromatography – 5

a. **Gas chromatography:** Theory, Instrument description of equipment and different parts, columns (packed and capillary columns), detector specifications-thermal conductivity detector, flame ionization detector, electron capture detector, nitrogen-phosphorus detector, photo ionization detector, programmed temperature gas chromatography; applications in the analysis of gases, petroleum products etc., other detectors used their Principles and Applications.

b. GC-MS – Introduction

Instrumentation – GC – MS interface – Mass spectrometer (MS) Instrument Operation, processing GC – MS data – ion chromatogram Library searching – Quantitative measurement – sample preparation Selected ion monitoring – Application of GC-MS for Trace constituents. Drugs analysis, Environmental Analysis and others.

c. Counter current chromatography-principles and application, Affinity chromatography- principles and applications

Text books:

1.R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York

2. M.N. Sastri ,Separation methods, Himalaya Publishing Company, Mumbai

Reference books:

1.E. Helfman, Chromatography, Van Nostrand, Reinhold, New York

2.E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.

3.Chemical separation methods, John A Dean, Von Nostrand Reinhold, New York

4.R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York

5.H.M Mc Nair and J. M. Miller, Basic Gas Chromatography, John Wiley, New York

6.W. Jeumings, Analytical Gas chromatography, Academic Press, New York

7.H. Eugelhardt (ed), Practice of HPLC, Springer Verrag, Berrin

M.Sc. DEGREE EXAMINATION (Model Question Paper)
M.Sc. (Final) Chemistry - Third semester
Specialization – ANALYTICAL CHEMISTRY
Paper I – SEPERATION METHODS – I
(With effect from the admitted batch of 2021-2022 Academic Year)

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer All Questions (5 x 16 = 80 marks)

1. (a) Write brief notes on :
   i. Partition chromatography
   ii. Retardation factor
   iii. Retention time
   iv. Retention volume

Or

(b) i) What is theoretical plate theory of chromatography?
ii) Explain the classification of different chromatographic methods?

2. (a) Discuss the following:
   i. Zone spreading
   ii. HETP
   iii. Van Deemter Equation
   iv. Choice of column

Or

(b) Explain the following development methods in paper chromatography:
i) ascending,
ii) descending,
iii) horizontal,
iv) circular spreading and multiple developments.

3. (a) i) Discuss the principle, instrumentation and applications of HPTLC.
ii) Write the different visualization methods in TLC.

Or

(b) Write short notes on the following topics in adsorption chromatography:
i. Important requirements of a satisfactory adsorbent
ii. Considerations while choosing a solvent in adsorption column
iii. Factors effecting the column efficiency
iv. Applications

4. (a) What is capillary electrophoresis? Give the details of the instrument and its applications to organic compounds.

Or

(b) Explain clearly
   i. Exclusion chromatography
   ii. Molecular sieve chromatography

5. (a) i) What is gas chromatography? Illustrate a gas chromatographic instrument and describe components.

ii) What are the important advantages of gas chromatography?

Or

(b) i) Discuss the principles and applications of counter current chromatography

ii) Explain application of GC-MS for Trace constituents

Andhra University
Department of Inorganic and Analytical Chemistry
M. Sc.(Final) Chemistry Specialization: *Analytical Chemistry*
Paper- II: Quality control and Traditional methods of Analysis-I
(Effective from admitted batch 2021-2022)

Course Objectives

CO 1 : To impart basic and fundamental knowledge of Quality Control in analytical Chemistry.

CO 2 : To impart knowledge on principle of decomposition and dissolution techniques of sample

CO 3 : To learn and practice about analytical chemistry of some selected oxidant systems

CO 4 : To inculcate basic knowledge in organic functional group analysis

Learning Outcomes

LO 1 : Gain knowledge about quality of an analytical procedure, limit of detection, sensitivity, safety, cost measurability, selectivity and specificity, quality control

LO 2 : Study about **ISO 9000** and **ISO 14000** series-meaning of quality, quality process model, customer requirement of quality calibration and testing, statistical process control.

LO 3 : Gain knowledge on , control chart, statistical quality control, acceptance sampling. Good laboratory practices (GLP) – need for GLP, GLP implementation and organization, GLP status in India.

LO 4 : Learn about Principles of decomposition at high temperatures, high pressures Principles of Microwave and ultrasonic decomposition techniques.

LO 5 : Learn about species responsible for the oxidation properties, stability of the solutions, standardization, requirement for the selections of the oxidants.

LO 6 : Gain knowledge on Classification of functional groups with suitable examples.

Andhra University
Department of Inorganic and Analytical Chemistry
M. Sc.(Final) Chemistry Syllabus for 3rd Semester
Specialization: *Analytical Chemistry*
Paper- II: Quality control and Traditional methods of Analysis-I
(Effective from admitted batch 2021-2022)

Unit – I: Quality control in Analytical Chemistry

a. **Characteristics of an analysis**:quality of an analytical procedure, limit of detection, sensitivity, safety, cost measurability, selectivity and specificity, quality control-principles of Ruggedness test, control charts, Youden plot, and ranking test.

b. **Quality assurance and management systems:** elements of quality assurance, quality assurance in design, development, production and services, quality and quantity management system, **ISO 9000** and **ISO 14000** series-meaning of quality, quality process model, customer requirement of quality calibration and testing, statistical process control, process control tools, control chart, statistical quality control, acceptance sampling.

c. **Evaluation and reliability of analytical data:** limitation of analytical methods, accuracy, precision, errors in chemical analysis, classification of errors, minimization of errors, significant figures, computations and propagation of errors.

d. Brief out line of ICH guide lines on drug substances and products.

Unit – II

a. Statistical analysis: Mean deviation, Standard deviation, coefficient of variance, normal distribution, F test, T test, rejection of results, presentation of data.
b. Good laboratory practices (GLP) – need for GLP, GLP implementation and organization, GLP status in India.
c. Decomposition and Dissolution of Inorganic Compounds

Principle of decomposition and Dissolution. Difference between dissolution/decomposition of Organic and Inorganic substances.
Importance of Decomposition Techniques in Analysis.
Principle of Dissolution of an inorganic substance.
Decomposition of samples with acids – H_2O, HCl, HF, HNO_3, H_2SO_4 and $HClO_4$

Unit – III

a. Decomposition of samples by fusion, Principle and with two examples each
Alkali Fusion--- Na_2CO_3, NaOH,
Acidic Fusion--- Sodium Hydro Sulphate, Sodium Pyro Sulphate
Oxidation Fusion---Na_2O_2, Sodium Chlorate
Reductive Fusion $Na_2CO_3 + Na_4BO_4$
What is Sintering process, How is it different from Fusion.

Fusion with alkali carbonates, alkali hydroxides, Sodium Peroxide
Decomposition of samples by sintering with sodium peroxide, sodium carbonate.
Principles of decomposition at high temperatures, high pressures .
Principles of Microwave and ultrasonic decomposition techniques.

b. Organic Compounds

Principles of solubility of organic compounds, non polar, polar solvents.
Recrystallisation methods and application of solubility and Recrystallisation.

Unit – IV Oxidant systems – Principles and applications in analysis

Analytical chemistry of some selected oxidant systems – formal, standard and normal potentials in various media, species responsible for the oxidation properties, stability of the solutions, standardization, requirement for the selections of the oxidants, selection of suitable indicators for Oxidant systems.

a) Inorganic Systems Mn (III), Mn (VII), Ce (IV), Cr (VI), V (V), periodate, iodate,
b) Organic Systems chloramine-T.

Unit – VOrganic Functional group analysis

Classification of functional groups with suitable examples.
Determination of:

1) Functional groups imparting acidic nature – thiol, enediol, phenolic hydroxyl.
2) Functional groups imparting basic nature – Aliphatic and Aromatic primary, secondary and tertiary amines – hydrazine derivatives.
3) Functional groups which impart neither acidic nor basic nature – Aldehydes, Ketones, Nitro, Methoxy, Olifinic.

Text books:

1. Technical methods of analysis – Griffin, McGraw Hill Book Co.
2. Chemical Separation and measurements – D.G Peterseti, John M.Haves Sanders Co.
3. Chemical analysis – H.A Laitinan, McGraw Hill Book Co.
4. Newer redox titrants – Berka, Zyka and Vulterin, Pergamon Press
5. Volumetric Analysis, Vol III – I.M Kolthoff and R. Belcher, Interscience Public, New York
6. Vogel's Text Book of Inorganic Quantitative Analysis – J. Bassett et al, ELBS
7. Organic functional groups – S. Siggia

Reference Books:

1. D.A Skoog, D.M West and F.J Holler, Analytical Chemistry, An Introduction, Sanders College Publishing, New York
2. K.V.S.G Murali Krishna, An Introduction ISO 9000, ISO 1400 Series, Environmental Management
3. Quality Assurance and Good Laboratory Practices, Prof. Y. Anjaneyulu, In Now Publication, New York
4. Quality Assurance in Analytical Chemistry – G.Kateman and F.W Pijpers, John Wiley and Sons, New York
5. Quantitative Chemical Analysis – I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London
6. Decomposition Techniques in Inorganic Analysis – J.Dolezal, P.Povondra, Z.Sulcek

DEPARTMENT OF INORGANIC AND ANALYTICAL CHEMISTRY
M.Sc. DEGREE EXAMINATION (Model Question Paper)
M.Sc. (Final) Chemistry - 3rd semester
Specialization – ANALYTICAL CHEMISTRY
Paper II –QUALITY CONTROL AND TRADIONAL METHODS OF ANALYSIS– I
(Effective from admitted batch 2021-2022)

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer ALL Questions (5 x 16 = 80 marks)

1. (a) i) Explain the classification of errors and propagation of errors.
ii) What is the importance of ICH guidelines for analysis of drug substance?

Or

(b) i) Explain is the classification and importance of ISO 9000 quality Management System?
ii) Write a note on significant figures?

2. (a) Write short notes on :
i) Some of the Good Laboratory Practices (GLP) and
ii) GLP status in India.

Or

(b) i) Discuss the principle involved in the decomposition of samples by HCl and HNO_3, and give examples for each of them.
ii) Discuss the Q-test for rejection of data.

3. (a) i) Discuss the principle involved in the decomposition of samples by alkali, acid , oxidation and reductive fusions, and give two examples for each of them.
ii) Explain the principle of microwave decomposition technique?

Or

(b) i) Explain the decomposition of samples by sintering with sodium peroxide and sodium carbonate.
ii) What is the use of recrystalisation and give the procedure for selection of solvent for recrystalisation

4. (a) i) Bring out the differences between formal, standard and normal potentials of oxidants in various media
ii) Give examples for primary standard and secondary standard oxidizing agents, and explain the procedure for standardization of one of the secondary standard oxidizing agent

Or

(b) i) Discuss the preparation, properties, standardization, stability and applications of iodate and periodate solutions.
ii) Write the different types of redox indicators used in redox titrations?

5. (a) i) Give the classification of functional groups with suitable examples.
ii) Explain the principle, procedure and formulae involved in the estimation of organic compounds with hydroxyl groups like thiol and phenol.

Or

(b) i) How do you determine the organic compounds with the following functional groups?

i. Primary amines

ii. Nitro

iii. Methoxy.

M.Sc (Final) Chemistry Specialization -*Analytical Chemistry*
Paper – III: Applied Analysis-I
(Effective from 2021 - 2022 Admitted batch)

Course Objectives :

CO 1 : To impart basic and fundamental knowledge ongeneral techniques of analysis applied to complex materials.

CO 2 **:** To impart knowledge on scope of metallurgical analysis

CO 3 **:** To learn the analysis of various constituents of different ores finished products.

CO 4 : To inculcate basic knowledge about the Assessment of water quality.

Learning Outcomes :

LO 1 : Study about Analysis of ores: Iron ore- Analysis of the Constituents – Moisture , loss of ignition, Total Iron, ferrous Iron ,Ferric Iron, alumina , silica, Titania, Lime, Magnesia, Sulphur, phosphrous, manganese, alkalies, combined water, Carbon in blast furnace, flue dust and sinter.

LO 2 : Study about Phosphate rock - Analysis of the Constituents – CaO,P_2O_5, F, SiO_2,CO_2,S, Na_2O, Al_2O_3, Fe_2O_3, Mgo,K_2O,Cl,MnO. Organic carbon, Moisture, Loss of ignition

LO 3 : Gain knowledge about Analysis of steel for C, Si ,S, P, Mn, Ni, Cr; Mg and analysis of blast furnace slag .

LO 4 : Gain knowledge on Chemical Analysis of cement, oils, soaps and paints

LO 5 : Analytical methods for the determination of some anions and cations in water

LO 6 : Determination of Dissolved oxygen (D.O), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), standards for drinking water.

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc (Final) Chemistry Syllabus for 3rd Semester
Specialization -*Analytical Chemistry*
Paper – III: Applied Analysis-I
(Effective from 2021 - 2022 Admitted batch)

Unit – I
Analysis of Ores - I

(a) General techniques of analysis applied to complex materials - Scope of metallurgical analysis -
General methods of dissolution of complex materials - Various chemical methods for the effective separation of the constituents in the complex materials.

(b) Analysis of ores: Iron ore- Analysis of the Constituents – Moisture , loss of ignition, Total Iron, ferrous Iron ,Ferric Iron, alumina , silica, Titania, Lime, Magnesia, Sulphur, phosphrous, manganese, alkalies, combined water, Carbon in blast furnace, flue dust and sinter.

(c)Manganese Ore - Analysis of the Constituents – Total Manganese, MnO_2, SiO_2, BaO, Fe_2O_3, Al_2O_3, CaO, P and S

Unit – II
Analysis of Ores - II

(a) Chromite Ore - Analysis of the Constituents – Chromium, SiO_2, FeO, Al_2O_3CaO,&MgO.

(b) Phosphate rock Ore - Analysis of the Constituents - CaO,P_2O_5, F, SiO_2,CO_2,S, Na_2O, Al_2O_3, Fe_2O_3, Mgo,K_2O,Cl,MnO. Organic carbon, Moisture, Loss of ignition.

(c)Aluminium Ore (Bauxite) - Analysis of the Constituents – Silica, Alumina, Fe_2O_3,Titania, MnO, P_2O_5, CaO, MgO, vanadium, zirconium, and alkalies.

Unit – III
Analysis of Finished Products – I

(a) Analysis of steel for C, Si ,S, P, Mn, Ni, Cr; Mg and analysis of blast furnace slag .
(b) Analysis of refractory materials: fire clay, flour spar, and magnesite
(c) Analysis of fluxes - limestone and dolomite.

Unit – IV
Analysis of Finished Products – II

(a) Chemical Analysis of cement-silica, NH_4OH group, ferric oxide, alumina, lime, magnesia, SulphideSulphur , K_2O,Na_2O, free CaO in Cement and Clinker,SO_3 and loss on ignition.
(b) Analysis of oils - saponification number, iodine number, and acid number..
(c) Analysis of soaps - moisture, volatile matter, total alkali, total fatty matter, free caustic alkali or free fatty acids, sodium silicate , chloride.

(d) Analysis of paints-vehicle and pigment, $BaSO_4$,total lead and lead chromate

Unit – V
Assessment of water Quality

Sources of water, classification of water for different uses, types of water pollutants and their effects,
Analytical methods for the determination of the following ions in water:

Anions: CO_3^{2-}, HCO_3^-, F^-, Cl^-, SO_4^{2-}, PO_4^{3-}, NO_3^-, NO_2^-, CN^-, S^{2-}
Cations: Fe^{2+}, Fe^{3+}, Ca^{2+}, Mg^{2+}, Cr^{3+}, As^{5+}, Pb^{2+}, Hg^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, Co^{2+}
Determination of Dissolved oxygen (D.O), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), standards for drinking water.

Text books

1. Handbook of Analytical Control of Iron and Steel Production, Harrison John, Weily 1979
2. Standard methods of Chemical Analysis, Welcher
3. Technical Methods of Analysis, Griffin, McGraw Hill
4. Commercial Methods of Analysis, Foster Dee Sneel and Frank M. Griffin, McGraw Hill Book Co.
5. Water Pollution, Lalude, McGraw Hill
6. Environmental Chemistry, Anil Kumar De, Wiley Eastern Ltd.
7. Environmental Analysis, S.M. Khopkar (IIT Bombay)

M.Sc. DEGREE EXAMINATION (Model Question Paper)
M.Sc. (Final) Chemistry - Third semester
Specialization – ANALYTICAL CHEMISTRY
Paper III – APPLIED ANALYSIS – I
(With effective from admitted batch 2021-2022)

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer All Questions (5 x 16 = 80 marks)

1. (a) i) What are the general methods of dissolution of complex materials?
ii) Give the procedures for estimations of total iron, alumina and estimated present in iron ore?

Or

(b) i) Give the general procedures for the determination of moisture and loss of ignition of a sample.
ii) Explain the determination of Sulphur, Phosphorous in iron ore?

2. (a) Explain the analysis of
i. Chromium in chromite ore
ii. Alumina in bauxite and
iii. Cao and MgO in Phosphate Rock.

Or

(c) i) Explain the complete analysis of Chromite Ore
ii) Write the determination of Vanadium and Zirconium in Bauxite

3. (a) i) Describe the analysis of carbon, manganese and chromium in the steel sample.
ii) What are the main constituents of blast furnace ore?

Or

(b) i) Give the procedure for the analysis of different constituents of flour spar.
ii) How calcium in limestone can be estimated?

4. (a) i) What is the composition of cement?
ii) Discuss the complete analysis of cement.

Or

(b) Give the procedures for the estimation of following in a soap :
i. Total alkali
ii. Total fatty matter
iii. Free caustic alkali
iv. Sodium silicate

5. (a) i) Give the principle, importance of each reagent used in the estimation of dissolved oxygen of a water sample. Explain the detailed procedure for estimation.
ii) Define BOD and COD. Always COD is grater than BOD. why?

Or

(b) Explain the principle and procedure for the analysis of the following ions present in a water sample:
i. Nitrite
ii. Cyanide
iii. As^{5+}
iv. Co^{+2}

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc. (Final) Chemistry
Specialization - *Analytical Chemistry*
Paper – IV: INSTRUMENTAL METHODS OF ANALYSIS - I

(Effective from 2021-2022 Admitted batch)

Course Objectives :

CO 1 :. To impart basic and fundamental knowledge of various molecular spectroscopic techniques like UV-Visible Spectroscopy,Vibrational Spectroscopy,Raman spectroscopy, NMR and ESR, XRF and Mass Spectrometry.

CO 2 : To impart knowledge on applications of several spectroscopic techniques in analytical chemistry.

CO 3 : To impart basic and fundamental knowledge of fluorescence and phosphorescence, their applications in analytical chemistry

CO 4 : To inculcate basic knowledge on role of instrumental methods in analytical chemistry.

Learning Outcomes :

LO 1 : Gain knowledge about Introduction to UV-Visible spectroscopy, deviation from Beer's law; Instrumentation- single and double beam spectrophotometers,

LO 2 : Gain knowledge about spectrophotomeric titrations, applications- general precautions in colorimetric determinations, colorimetric determination of Fe^{2+}, Fe^{3+}, Al^{3+}, NH^{4+}, Cr^{6+}, Co^{3+}, Cu^{2+}, Ni^{2+}, $NO_2^-$and PO_4^{3-} using suitable reagents,

LO 3 : Learn about Quenching of fluorescence and types of Quenching, Instrumentation, advantages and limitations of fluorimetry. Applications-determination of Al^{3+}, chromium salts, Li^+, fluorescence, thiamin (B1) and riboflavin (B12), nicotinamide and methyl dopa.

LO 4 : Understand about dispersive IR spectrophotometer, Non-dispersive IR spectrophotometer for analysis of *CO and other* organic compounds, principle of FTIR spectrometer, Attenuated Total Reflection (ATR) IR

LO 5 : Learn about Qualitative and quantitative analysis with reference to petroleum industry and polymer industry, Identification of drug substances and identification of impurities in a drug sample.

LO 6 : Understand the Mass Analyzers: Magnetic sector mass analyzer (single and double focusing), Quadruple, Ion traps, Time of flight (TOF); Ion detectors, FTMS, Tandem mass spectrometry(MS^n), qualitative analysis, molecular weight determination, quantitative analysis.

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc. (Final) Chemistry Syllabus for 3rd Semester
Specialization - *Analytical Chemistry*
Paper – IV: INSTRUMENTAL METHODS OF ANALYSIS - I

(Effective from 2021-2022 Admitted batch)

Unit – I :

(a) *UV-Visible Spectroscopy:* Introduction to UV-Visible spectroscopy, deviation from Beer's law; Instrumentation- single and double beam spectrophotometers, sources of radiation, filters and monochromators, sample cells, detectors. Principle of diode array spectrophotometers, Principle of UV-visible diffuse reflectance spectrophotometer, spectrophotomeric titrations, applications- general precautions in colorimetric determinations, colorimetric determination of Fe^{2+}, Fe^{3+}, Al^{3+}, NH^{4+}, Cr^{6+}, Co^{3+}, Cu^{2+}, Ni^{2+}, $NO_2^-$and PO_4^{3-} using suitable reagents, simultaneous determinations of dichromate and permanganate in a mixture, determinations of aromatic primary amines, riboflavin and paracetamol.

Unit – II:

(a) Spectrofluorimetry: Theory of fluorescence, and phosphorescence, types of fluorescence, factors affecting fluorescence intensity, relationship between fluorescence intensity and concentration; Quenching of fluorescence and types of Quenching, Instrumentation, advantages and limitations of fluorimetry. Applications-determination of Al^{3+},chromium salts, Li^+, fluorescence, thiamin (B1) and riboflavin (B12), nicotinamide and methyl dopa.

(b) Raman Spectroscopy: Theory, instrumentation, sample handling, instrumentation, Raman spectra of HCN,CO, CO_2, N_2O, H_2O and quantitative analysis.

Unit – III :

Infrared Spectroscopy: Introduction to Infrared Spectroscopy, characteristic frequencies of organic compounds, instrumentation – IR sources, **sample cells,** sample preparations techniques, detectors; dispersive IR spectrophotometer, Non-dispersive IR spectrophotometer for analysis of *CO and other* organic compounds, principle of FTIR spectrometer, Attenuated Total Reflection (ATR) IR. Qualitative and quantitative analysis with reference to petroleum industry and polymer industry, Identification of drug substances and identification of impurities in a drug sample.

Unit – IV :

(a) NMR Spectroscopy: Introduction to NMR spectroscopy-resonance condition, nuclei with quadruple moments, relaxation process and causes for relaxation process (Magnetic dipole-dipole interactions,paramagnetic relaxation,chemical shift anisotropy, quadruple relaxation, scalar relaxation and spin rotation relaxation), chemical shift, factors affecting chemical shift, shielding, spin-spin splitting, mechanism for spin-spin coupling, factors affecting the germinal and vicinal coupling, NMR Instrumentation, sample preparations, FT NMR, Solid state magic angle NMR; **spin-decoupling experiments**-double resonance, off-resonance, spin tickling, nuclear over house effect and shift reagents; NMR of other than proton-^{13}C, ^{15}N, ^{19}F, ^{31}P, and ^{11}B. Variable temperature NMR experiment for fast chemical reactions and fluxional molecules.

(b) ESR Spectroscopy: principle, g value, hyper fine splitting, qualitative analysis, Kramer's degeneracy, fine splitting, instrumentation, introduction to double resonance technique, difference between ESR and NMR spectra, ESR spectra of free radicals and other analytical applications.

Unit – V:

(a) Mass Spectroscopy: *P*rinciple, types of peaks observed, resolution**, Instrumentatio**n-**sample inlet systems** (batch inlet, direct probe, chromatographic and capillary electrophoretic),

Ionization techniques: Electron impact ionization, Electrospray ionization, Chemical ionization, atmospheric pressure chemical ionization,Matrix-assisted laser desorption ionization, fast atom bombardment and inductive coupled plasma**; Mass Analyzers**: Magnetic sector mass analyzer (single and double focusing), Quadruple, Ion traps, Time of flight (TOF); **Ion detectors**, FTMS, Tandem mass spectrometry(MS^n), qualitative analysis, molecular weight determination, quantitative analysis.

(b) X-Ray Spectroscopy (XRF): **basic principle,** Instrumentation- energy dispersive and wavelength dispersive techniques, chemical analysis by X-ray spectrometers, matrix effects, applications.

Text Books:

1. Instrumental methods of analysis – H.H Willard, Meritt Jr. and J.A Dean
2. Principles of instrumental analysis – Skoog and West
3. Vogels Textbook of Quantitative Inorganic analysis – J. Basset, R.C Denney, G.H Jefferey and J.Madhan
4. Instrumental methods of analysis – B.K Sarma, Goel Publishing House, Meerut
5. Instrumental methods of Analysis – Ewing
6. Handbook of ICP- Bogdain B.
7. Analytical Chemistry Instrumental techniques, Maninder Singh,Dominent Publishers, New Delhi, 2002.
8. Mass spectrometry for Chemists and Biochemists, Robert A.W. Johnstone and Macolm.E. Rose, 2th ed Cambridge University Press 1996.
9. Structural methods in Inorganic chemistry - E.A.V. Ebsworth, et al ELBSPublications,1988
10. Physical methods for Chemists, Russell S. Drago second edition, Saunders College publishing 1992.
11. Mass Spectrometry Basics, Herbert, Christopher G.; Johnstone, Robert A.W., CRC Press.

Reference Books:

1. Applications of ICP-MS, A.R Date and A.L Glay, London (Eds), Blackie, London
2. A. Moutaser and D.W Gologhtly (Eds), ICP in Analytical Atomic Spectrometry, VeH Publishers, New York
3. G.I Moore, Introduction to ICP emission Spectrometry in Analytical Spectroscopy, Elsevier, Amsterdam
4. Infrared and Raman Spectra of Inorganic and Coordination Compounds,KazuoNakamoto, 5th ed., John Wiley & Sons, 1995.
5. Instrumental methods of Analysis – Chatwal and Anand
6. 16. Mass Spectrometry-A Textbook by Jürgen H. Gross, © Springer-Verlag Berlin Heidelberg 2004, Printed in Germany.

DEPARTMENT OF INORGANIC AND ANALYTICAL CHEMISTRY

M.Sc. DEGREE EXAMINATION (Model Question Paper)

M.Sc.(Final) Chemistry - 3rd semester

Specialization – ANALYTICAL CHEMISTRY

Paper IV –INSTRUMENTAL METHODS OF ANALYSIS – I

(**With Effective from 2021-2022 Admitted Batch**)

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer ALL Questions (5 x 16 = 80 marks)

1. (a) i) What is Beer's Law and give the reasons for positive and negative deviations?
   ii) What are spectrometric titrations? Explain (i) procedure involved in spectrophotometric titrations and (ii) Advantages of these titrations.

Or

(b) i) How thiamin and riboflavin in drug samples are determined using spectrophotometry?
   ii) Explain the simultaneous determination of Cr(VI) &Mn(VII) using spectrophotometer

2. (a) i) Explain the instrumentation of Raman spectrometer, explain how Raman spectroscopy is useful for structural elucidation of CO, CO_2, H_2O, N_2O.
   ii) What is Raman Effect and given the conditions for a molecule to be Raman active.

Or

(b) i) Explain the phenomenon fluorescence and phosphorescence
   ii) Deduce the relation between intensity of fluorescence and concentration

3. (a) i) Discuss various type of molecular vibrations.
   ii) Explain the functions of various components in IR spectrophotometer with the help of a neat sketch of IR spectrophotometer

Or

(b) i) Explain how fingerprint region in IR spectroscopy is useful for analytical chemistry
   ii) Write the theory and working of non dispersive IR spectrometer

4. (a) i) Discuss the applications of chemical shift, intensity of peaks and spin-spin splitting in the interpretation of NMR spectra with one example.
   ii) Bring out the use of shift reagent in NMR spectroscopy.

Or

(b) i) Write a short note on 'g' Value.
   ii) Draw a neat sketch of ESR Spectrometer and explain each component in it.

5. (a) i) What is nitrogen rule and how it is useful to have an idea about the mass of the given organic molecule?
   ii) Write short note on:
      (i) Resolution in a mass spectrometry.
      (ii) Meta stable ions.

Or

(b) i) Write about matrix effect.
   ii) Discuss in detail about the instrumentation in X-ray spectroscopy.

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc (Final) Chemistry Syllabus for 3 rd Semester
Specialization - Analytical Chemistry
ANALYTICAL CHEMISTRY PRACTICAL – I
(With effect from 2021-2022 admitted batch)

Classical Methods of Analysis-1

1. Water analysis
   (i) Determination of total hardness (Ca^{2+} and Mg^{2+}) of water samples
   (ii) Determination of chloride (Cl^-) present in water samples
   (iii) Determination of dissolved oxygen (DO) of drinking water and sewage water

2. Complex metric titrations
   (i) Determination of the concentration of calcium in milk powder by complexometric titration (EDTA)
   (ii) Determination of Calcium and Magnesium in limestone or dolomite samples using EDTA.

3. Fertilizer analysis
   (i) Determination of ammonia from ammonia containing fertilizer
   (ii) Determination of phosphate from fertilizer

4. Analysis of iron ore
   (i) Complete analysis of iron ore
   (ii) Determination of percentages of Fe (II) and Fe (III) present in iron ore sample

5. Analysis of Coal
   (i) Determination of moisture content of coal sample
   (ii) Determination of volatile matter of coal sample
   (iii)Determination of fixed carbon of coal sample
   (iv) Determination of ash content of coal sample

Instrumental Methods of Analysis-1

1. pH metry
   (i) Determination of alkalinity of a coloured effluent using pH metric titration.
   (ii) Determination of purity of commercial HCl using pH metric titration.
   (iii)Determination of purity of commercial H_2SO_4 using pH metric titration.

2. Conductometry
   (i) Determination of concentration of strong acid using strong base
   (ii) Determination of concentration of weak acid using strong base
   (iii)Determination of sodium carbonate using strong base

3. Potentiometry

(i) Determination of Cr(VI) with Fe(II) using potentiometric end point
(ii) Determination of Fe (II) using ceric sulphate by potentiometric end point
(iii) Determination of a mixture of Ce(IV) and V(V) with Fe(II) by potentiometric end point
(iv) Determination of KSCN with $AgNO_3$ by potentiometric end point.

4. Spectrophotometry
(i) Determination of Fe (III) using potassium thiocyanate
(ii) Determination of Iron(II) using orthophenanthroline
(iii) Determination of phosphate in fertilizer and cola drinks by Molybdenum blue method
(iv) Determination of Manganese (II) -periodate method

5. Flame photometry
(i) Determination of sodium present in bread samples
(ii) Determination of sodium and potassium in a given sample of fertilizer

6. Thin layer chromatography: Determination of Rf values and identification of organic compounds in a given mixture by TLC
(i) Separation of mixture of benzil and 2-nitrophenol
(ii) Mixture of benzophenone and naphthalene
(iii) Mixture of 2-nitrophenol and 4-nitrophenol

References:
1. A Text Book of Quantitative Inorganic Analysis (3rd Edition) – A. I. Vogel

M.Sc.(Final) Chemistry **Analytical Chemistry** Specialization
4th Semester Paper - I: **Separation Methods – II**
(with effective from 2021-2022 admitted batch)

Course Objectives :

CO 1 : To impart basic and fundamental knowledge onion exchange methods and solvent extraction.

CO 2 : To impart knowledge on some important sampling techniques and methods.

CO 3 : To learn and practice the importance of Analytical Chemistry to Industrial Research

CO 4 : To inculcate basic knowledge in modern separation techniques like HPLC, LC - MS.

Learning Outcomes :

LO 1 : Gain knowledge on principles of ion-exchange systems, synthetic ion-exchange resins, properties of anion and cation exchange resins,

LO 2 : Study about ion-exchange mechanism, ion-exchange equilibria, selectivity, ion-exchange capacity, applications of ion-exchangers in different fields.

LO 3 : Understand about - Theory, Instrument description of the different parts of the equipment, columns, detectors-UV detector, refractometric detector, Fluorescence detector, Diode Array detector,

LO 4 : Understand about units, concentrations, calculations, standards, chemical reactions, expressions of concentrations, importance of separation methods with examples.

LO 5 : Learn the Sampling of different types of liquids: different sampling techniques, sampling of drinking water, industrial effluents, precautions in sampling and preservation of collected liquid samples

LO 6 : Learn about sampling and Pre-concentration by adsorption or absorption method, instantaneous monitoring, sampling in samplers and subsequent monitoring, different types of gas samplers, precautions in preservation of samples, systematic sampling and random sampling

LO 7: Study about the Development and validation of an analytical method, units, concentrations, calculations, standards, chemical reactions, expressions of concentrations, importance of separation methods with examples.

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc.(Final) Chemistry Syllabus for 4th Semester
Specialization -**Analytical Chemistry**
Paper - I: **Separation Methods – II**
(with effective from 2021-2022 admitted batch)

Unit – I

(a) Ion Exchange: principles of ion-exchange systems, synthetic ion-exchange resins, properties of anion and cation exchange resins, ion-exchange mechanism, ion-exchange equilibria, selectivity, ion-exchange capacity, applications of ion-exchangers in different fields.

(b) Ion exchange chromatography: Principle, Equipment, Application SpecificallySeparations of Lanthanides, Actinides, amino acids.

(c) Ion chromatography:principles of separation, instrumentation, detectors, separation of cations and anions, applications in the analysis of water and air pollutants.

Unit – II

High performance liquid chromatography: Theory, Instrument description of the different parts of the equipment, columns, detectors-UV detector, refractometric detector, Fluorescence detector, Diode Array detector, applications in the separation of organic compounds, names of other detectors used their Principles and Applications.

LC-MS– Introduction – Instrumentation – liquid chromatograph – Mass spectrometer Interface – Instrumental details – Processing LC-MS data – ion chromatograms – Library searching – Quantitative measurements.
Sample preparation – selected ion monitoring. Application of LC-MS for Drug analysis, Environmental samples and others.

Unit - III

d.**Liquid-liquid partition chromatography:**principle supports, partitioning liquids, eluents, reverse phase chromatography, apparatus and applications

e. Development and validation of an analytical method, units, concentrations, calculations, standards, chemical reactions, expressions of concentrations, importance of separation methods with examples.

f. **Sampling:** Basis of sampling, purpose of sampling, homogeneous and heterogeneous samples, statistical criteria for good sampling, sample size, sampling unit, gross sample, laboratory sample.

Unit – IV

Sampling of Solids: Cone and Quartering method, Long pile and alternative shovel method, precautions in preservation of solid samples, sampling of metals and other solids rods, wires, sheets, plates, especially Gold, Silver, Iron and other metals.Sampling of

different types of liquids: different sampling techniques, sampling of drinking water, industrial effluents, precautions in sampling and preservation of collected liquid samples.**Sampling of gases**: sampling and Pre-concentration by adsorption or absorption method, instantaneous monitoring, sampling in samplers and subsequent monitoring, different types of gas samplers, precautions in preservation of samples, systematic sampling and random sampling.

Unit – V

(a) Importance of Analytical Chemistry to Industrial Research: Importance of Qualitative and Quantitative analysis in research and development, industries and other branches of science.

(b) Solvent Extraction: principles and processes of solvent extraction, Distribution Law and Partition coefficient, nature of partition forces, different types of solvent extraction systems – Batch extraction, Continuous extraction, Counter current extraction, solvent extraction systems, applications in metallurgy, general applications in analysis and pre-concentration, special extraction systems like crown ethers, super fluid and surfactant extractions-examples.

Text books:

8.R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York

9. M.N. Sastri ,Separation methods, Himalaya Publishing Company, Mumbai

Reference books:

3.E. Helfman, Chromatography, Van Nostrand, Reinhold, New York

4.E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.

10. Chemical separation methods, John A Dean, Von Nostrand Reinhold, New York
11. R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
12. H.M Mc Nair and J. M. Miller, Basic Gas Chromatography, John Wiley, New York
13. W. Jeumings, Analytical Gas chromatography, Academic Press, New York
14. H. Eugelhardt (ed), Practice of HPLC, Springer Verrag, Berrin

M.Sc. DEGREE EXAMINATION (Model Question Paper)

M.Sc.(Final) Chemistry - Fourth semester

Specialization – ANALYTICAL CHEMISTRY

Paper I –SEPARATION METHODS -II

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer ALL Questions (5 x 16 = 80 marks)

1. (a) i) Give the principles of separation in ion chromatography.
ii) Explain the principle and equipment in ion exchange chromatography. Discuss its application in the separation of amino acids.

Or

(b) Explain the following: i) anion and cation exchange resins, ii) ion-exchange Mechanism, iii) ion exchange capacity and iv) regeneration of ion exchange resins.

2. (a) i) Discuss in detail the principle, instrumentation, advantages and applications of HPLC.
ii) Why liquid chromatography is a good technique for the separation of protein and nucleosides?

Or

(b) i) Explain the instrumentation of LC-MS
ii) Discuss the applications of LC-MS in analysis of drug and environmental samples.

3. (a) i) Explain the different types of concentration units
ii) Write the parameters for analytical method development and validation

Or

(b) i) Discuss the basis and purpose of sampling.
ii) Differentiate the stratified and random sampling.

4. (a) i) Discuss in detail about sampling of different types of liquids and preservation of Collected liquid samples
ii) Explain different methods for instantaneous monitoring of gases.

Or

(b) i) Explain different methods for sampling of solids.
ii) Write different types of gas samplers

5. (a) i) Give the importance of qualitative analysis in R&D and industries.
ii) What are crown ethers and explain their use in solvent extraction?

Or

(b) i) Give the principles and processes of solvent extraction and show that multiple extraction is better than a single extraction.
ii) Write short notes on batch extraction, continuous extraction and counter current extraction.

M. Sc.(Final) Chemistry
Specialization: *Analytical Chemistry*
Paper- II: Quality control and Traditional methods of Analysis-II
(with effective from 2021-2022 admitted batch)

Course Objectives

CO 1 : To impart knowledge on different precipitation methods.

CO 2 : To learn about principle of gravimetric and electro gravimetric analysis.

CO 3 : To understand about analytical chemistry of some selected reductant systems

CO 4 : To acquire knowledge on basic considerations of drugs and their analysis.

Learning Outcomes :

LO 1 : Gain knowledge about Crystal habit and super saturation, nucleation and crystal growth, homogeneous and heterogeneous nucleation,

LO 2 : Study about completeness of precipitation , effect of excess precipitant, pH, complex formation, temperature, purity of precipitates, aging.

LO 3 : Gain knowledge ontheory of PFHS, methods of PFHS – increase in pH, decrease in pH, cation release, anion release, reagent synthesis, change in oxidation state,

LO 4 : Gain knowledge about electrolysis at constant current, determination of Cu^{2+} by constant current electrolysis, electrolysis at controlled potentials, determination of Cu, Pb, Sn in brass and bronze by controlled potential electrolysis.

LO 5 : Learn about species responsible for the reduction properties, stability of the solutions, standardization, requirement for the selections of the reductant,

LO 6 : Learn about selection of suitable indicators for Reductant systems.

a) Inorganic Systems Cr (II), V (II), Ti (III), Sn (II), Fe (II) in H_3PO_4 and hydrazine,

b) Organic Systems hydroquinone and Ascorbic acid.

LO 7 : Gain knowledge on Classification of drugs with suitable examples

Andhra University
Department of Inorganic and Analytical Chemistry
M. Sc.(Final) Chemistry Syllabus for 4th Semester
Specialization: *Analytical Chemistry*
Paper- II: Quality control and Traditional methods of Analysis-II
(with effective from 2021-2022 admitted batch)

Unit – I: Precipitation methods-I

(a) Crystal habit and super saturation, nucleation and crystal growth, homogeneous and heterogeneous nucleation, solubility and particle size, colloids, completeness of precipitation , effect of excess precipitant, pH, complex formation, temperature, purity of precipitates, aging.

(b) Co-precipitation and post precipitation : theory of adsorption of salts having an ion in common with the main precipitate, co-precipitation in colloidal precipitates, adsorption of solvents, mixed crystal formation by occlusion and entrapment, re-precipitation with examples, Post-precipitation – theory of post-precipitation, examples of post-precipitation, conditions for obtaining pure and quantitative precipitates.

Unit –II: Precipitation methods-II

a. Precipitation Titrations: Principle, Indicators for precipitation titrations, determination of halides.

b. ***Precipitation from Homogeneous Solution (PFHS):*** theory of PFHS, methods of PFHS – increase in pH, decrease in pH, cation release, anion release, reagent synthesis, change in oxidation state, photochemical reactions, precipitation from mixed solvents. Applications of PFHS methods.

Unit –III: Gravimetric determinations

a. Gravimetric determinations*:* nature of species, preparation of solutions, limitations, interferences, inorganic precipitants-chloride and sulphate, organic precipitants dimethyl glyoxime (DMG), oxine, benzidine, salicylaldoxime, benzoin oxime, sodium tetraphenylboron, tetraphenylarsonium chloride.

b. Electro-gravimetric analysis:principle, important terms in electrogravimetry, decomposition voltage or decomposition potential, over voltage and their importance, instrumentation, electrolysis at constant current, determination of Cu^{2+} by constant current electrolysis, electrolysis at controlled potentials, determination of Cu, Pb, Sn in brass and bronze by controlled potential electrolysis.

Unit –IV

Analytical chemistry of some selected reductant systems – formal, standard and normal potentials in various media, stability of the solutions, species responsible for the reduction properties, standardization, requirement for the selection of the reductants, selection of suitable indicators for various reductant systems,

(a) Inorganic Systems – Cr (II), V (II), Ti (III), Sn (II), Fe (II) in H_3PO_4 and hydrazine,

(b) Organic Systems – hydroquinone and Ascorbic acid.

Unit –V

Basic considerations of drugs – Classification
Determination of the following Drugs:

1) Actyl salicylic acid (Antipyretic – Analgesic)
2) Testosterone, progesterone and cortisone (Steroids and corticoids)
3) Sulphadiazine(sulphadrugs)
4) Phenobarbitone (Barbituric acid derivatives)
5) Chloramphenicol, Benzyl penicillin and Tetracycline (Antibiotics)
6) Thiamine (B1), Riboflavin (B2) and ascorbic acid (c) [Vitamins]
7) Isoniazid (Antimicrobacterial agents)
8) Methlydopa (Antihypertensive agents)
9) Metronidazole (Antiamoebic agents).

Text books:

7. Technical methods of analysis – Griffin, McGraw Hill Book Co.
8. Chemical Separation and measurements – D.G Peterseti, John M.Haves Sanders Co.
9. Chemical analysis – H.A Laitinan, McGraw Hill Book Co.
10. Newer redox titrants – Berka, Zyka and Vulterin, Pergamon Press
11. Volumetric Analysis, Vol III – I.M Kolthoff and R. Belcher, Interscience Public, New York
12. Vogel's Text Book of Inorganic Quantitative Analysis – J. Bassett et al, ELBS
7. Organic functional groups – S. Siggia

Reference Books:

7. D.A Skoog, D.M West and F.J Holler, Analytical Chemistry, An Introduction, Sanders College Publishing, New York
8. K.V.S.G Murali Krishna, An Introduction ISO 9000, ISO 1400 Series, Environmental Management
9. Quality Assurance and Good Laboratory Practices, Prof. Y. Anjaneyulu, In Now Publication, New York
10. Quality Assurance in Analytical Chemistry – G.Kateman and F.W Pijpers, John Wiley and Sons, New York
11. Quantitative Chemical Analysis – I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London
12. Decomposition Techniques in Inorganic Analysis – J.Dolezal, P.Povondra, Z.Sulcek

M.Sc. DEGREE EXAMINATION (Model Question Paper)

M.Sc.(Final) Chemistry - Fourth semester

Specialization – ANALYTICAL CHEMISTRY

Paper II – TRADITIONAL METHODS OF ANALYSIS-II

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer ALL Questions (5 x 16 = 80 marks)

1. (a) i) Compare the contrast the co-precipitation and post- precipitation.
ii) Discuss in detail about the crystal growth

Or

(b) Explain the effect of following in completeness of precipitation
i) pH ii) complex formation iii) Temperature

2. (a) i) Discuss in detail about theory, various methods and advantage of PFHS.
ii) Write the applications of PFHS

Or

(b) i) Give the principle in precipitation titrations and discuss the various types of indicators used in precipitation titrations.
ii) Give the principle, p^H conditions and indicator used in Mohr's method for the determination of chlorides.

3. (a) i) Explain the preparation, stability, advantages and disadvantage of sodium tetra phenyl boron solution..
ii) Explain the electrolysis at constant electrolysis method and its application in the analysis of brass.

Or

(b) i) Explain the preparation, stability, advantages and disadvantage of oxine.
ii) Explain the term over voltage and write its importance

4. (a) i) Discuss the preparation, stability, standardization and applications of reductive systems V(II), Ti(III) and ascorbic acid.
ii) Differentiate the formal, standard and normal potentials

Or

(b) i) What is the general procedure for the selection of a suitable indicator in red-ox titrations.
ii) Discuss the preparation, stability, standardization and applications of reductive systems Cr (II), Sn (II) and hydroquinone.

5. (a) i) What are antimicrobial agents?
ii) What are sulpha drugs and give the procedure for the estimation of the sulfadiazine.

Or

(b) i) Discuss about ant amoebic agents.

ii) Discuss about antimicrobactirial agents and anti hypertensive agents. How is metronidazole estimated in the given sample?

AndhraUniversity
Department of Inorganic and Analytical Chemistry
M.Sc.(Final) Chemistry Specialization - *Analytical Chemistry*
Paper – III: Applied Analysis – II
(Effective from 2021-2022 Admitted batch)

Course Objectives

CO 1 : To impart basic and fundamental knowledge on analysis of raw materials

CO 2 : To impart knowledge on analysis of soil, fuel and fertilizer

CO 3 : To inculcate basic knowledge about the Assessment of air quality.

CO 4 : To learn the basic concepts and applications of Kinetic methods of analysis and Non aqueous titrimetry in analytical chemistry.

Learning Outcomes :

LO 1 : Gain knowledge about Analysis of non-ferrous alloys:

(i) Brass – Analysis of the constituents – Cu, Zn, Sn, Pb and Fe.

(ii) Bronze - Analysis of the constituents – Cu, Sn, Zn, Pb and Fe.

(iii) Solder - Analysis of the constituents – Sn, Pb and Sb.

LO 2 : Learn about Analysis of Ferro alloys :

(i) Ferro silicon - Analysis of the constituents – Si, C, P,S

(ii) Ferro vanadium - Analysis of the constituents – V, C, P, S. Si, Al.

(iii) Ferro manganese - Analysis of the constituents – Mn, S, C, P, Si

(iv) Silico manganese -Analysis of the constituents – Mn, S, C, P, Si

(v) Ferro chromium - Analysis of the constituents – Cr, C, Si.

LO 3 : Learn about Analysis of fuels: solid fuels-coal, proximate analysis, ultimate analysis, heating value, grading of coal based on Ultimate Heat Value(UHV).

LO 4 : Gain knowledge on Composition of pure air, classification of air pollutants, toxic elements present in dust and their sources – collection of air samples

LO 5 : Gain knowledge on introduction, slow reactions, catalyzed reactions, methods of determination of catalyst concentration

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc.(Final) Chemistry Syllabus for 4th Semester
Specialization - *Analytical Chemistry*
Paper – III: Applied Analysis – II
(Effective from 2021-2022 Admitted batch)

Unit – I Analysis of raw materials - I

Analysis of non-ferrous alloys:

(iv) Brass – Analysis of the constituents – Cu, Zn, Sn, Pb and Fe.
(v) Bronze - Analysis of the constituents – Cu, Sn, Zn, Pb and Fe.
(vi) Solder - Analysis of the constituents – Sn, Pb and Sb.

Unit – I Analysis of raw materials – II

Analysis of Ferro alloys :

(i) Ferro silicon - Analysis of the constituents – Si, C, P,S
(ii) Ferro vanadium - Analysis of the constituents – V, C, P, S. Si, Al.
(iii) Ferro manganese - Analysis of the constituents – Mn, S, C, P, Si
(iv) Silico manganese -Analysis of the constituents – Mn, S, C, P, Si
(v) Ferro chromium - Analysis of the constituents – Cr, C, Si.

Unit – IIIAnalysis of Soil, Fertilizer and Fuel

(a) Analysis of soils: sampling, determination of moisture, total N, P, Si, lime, humus nitrogen, alkali salts, soil absorption ratio.

(b) Analysis of fertilizers: ammonical fertilizers, Phosphate fertilizers, Nitrate fertilizers.

(c) Analysis of fuels: solid fuels-coal, proximate analysis, ultimate analysis, heating value, grading of coal based on Ultimate Heat Value(UHV).

Unit – IV Assessment **of Air Quality**

Composition of pure air, classification of air pollutants, toxic elements present in dust and their sources – collection of air samples.

Sources, effects, control of pollution and chemical analysis for the following.

(a) Primary pollutants:

(i) Carbon compounds - Carbon monoxide(CO) and Carbon dioxide(CO_2).
(ii) Sulphur compounds- sulphur dioxide (SO_2), Sulphur trioxide (SO_3) and Hydrogen Sulphide (H_2S).
(iii) Nitrogen compounds - nitric oxide (NO),and nitrogen dioxide (NO_2),
(iv) Hydrocarbons - Aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH).
(v) Particulate matter - Repairable and Suspended particulate matter, Inorganic and Organic particulates.

(b) Secondary pollutants - ozone (O_3), peroxy acetyl nitrate (PAN), peroxy benzyl nitrate (PBN)

(c) Standards for ambient air quality.

Unit- V Kinetic Methods of Analysis & Non aqueous Titrimetry

(a) Kinetic methods of analysis:introduction, slow reactions, catalyzed reactions, methods of determination of catalyst concentration, extrapolation method for the determination of catalyst, variable time method, fixed time method, examples for the determination of toxic metals and anions using some typical kinetic reactions.

(b)Non aqueous titrimetry :Classification of solvents and titrations for non aqueoustitrmetry- Types of reactions - Indicators .

(i) Determination of acids

(ii) Determination of bases

(iii) Karl-Fisher reagent for the determination of moisture content in drugs and other samples.

Text books

1. Chemical analysis – H.A Laitinan, McGraw Hill Book Co
2. Standard methods of Chemical Analysis, Welcher
2. Technical Methods of Analysis, Griffin, McGraw Hill
3. Commercial Methods of Analysis, Foster Dee Sneel and Frank M. Griffin, McGraw Hill Book Co.
4. Environmental Chemistry, Anil Kumar De, Wiley Eastern Ltd.
5. Environmental Analysis, S.M Khopkar (IIT Bombay)
6. Environmental Air Analysis, Trivedi and Kudesia, Akashdeep Pub.

M.Sc. DEGREE EXAMINATION (Model Question Paper)

M.Sc.(Final) Chemistry - Fourth semester

Specialization – ANALYTICAL CHEMISTRY

Paper III –APPLIED ANALYSIS-II

Time: Three Hours Maximum: 80 marks

SECTION - A

Answer ALL Questions (5 x 16 = 60 marks)

1. (a) i) Explain the analysis of Brass

Or

(b) i) Explain the analysis of Bronze

2. (a) i) Give the constituents of ferro vanadium and explain the procedure for the determination of any three constituents.
ii) Give the compositions of ferro chromium.

Or

(b) i) Give the constituents of ferro manganese and write their determination
ii) Explain the determination of Si & C in Ferro Silicon

3. (a) i) Explain sampling of soil and methods of its preservation.
ii) What is proximate analysis and how is it carried out? Give the significance of each parameter determined.

Or

(b) i) What is UHV? Discuss the grading of coal based on UHV.
ii) Give the procedure of the analysis of phosphate fertilizers.

4. (a) i) Give the composition of pure air.
ii) Explain the classification of air pollutants and methods of collection of air samples.

Or

(b) i) Give the sources and effects of SO_2& H_2S.
ii) Discuss the sources, effects and control of CO_2, N_2O, aliphatic hydrocarbons and respirable particulate matter.

5. (a) i) Give the classification of solvents.
ii) Discuss the determination of moisture content in drugs using Karl-Fisher reagent.

Or

(b) i) What is the principle involved in determination of weak acid using non aqueous titrimetry?
ii) How the toxic metals are determined using kinetic reactions.

M.Sc. (Final) Chemistry Syllabus for 4th Semester
Specialization - *Analytical Chemistry*
Paper - IV: Instrumental Methods of Analysis -II
(Effective from 2021-2022 Admitted batch)

Course Objectives

CO 1 : To impart basic and fundamental knowledge of atomic spectroscopic techniques like AAS, Flame Photometry and ICP – AES.

CO 2 : To impart knowledge on applications of several atomic spectroscopic techniques in analytical chemistry.

CO 3 : To impart basic and fundamental knowledge of thermal methods of analysis, their applications in analytical chemistry

CO 4 : To inculcate basic knowledge on electro analytical, radio analytical techniques in analytical chemistry.

Learning Outcomes :

LO 1 : Gain knowledge about theory-atomic line width, line broadening, sample introduction techniques-nebulization, electrothermal, direct insertion, hydride generation laser ablation,sputtering, arc and spark ablation; instrumentation-flame AAS and non-flame / furnace AAS, atomization techniques:

LO 2 : Study about flame, electrothermal, glow- discharge atomization, hydride atomization, cold-vapour atomization and Inductively coupled plasma, resonance line sources, hollow cathode lamp,

LO 3 : Study about Flame photometry: principle of flame photometry, theory, instrumentation, combustion flames, detectors, and analysis of Na, K, Ca, Mg, Li

LO 4 : Gain knowledge about Thermo gravimetry-theory, instrumentation, applications with special reference to $CuSO_4.5H_2O$, $CaC_2O_4.2H_2O$, $CaCO_3$, $(COOH)_2\ 2H_2O$

LO 5 : Learn about qualitative and quantitative analysis of inorganic ions-Cu, Bi, Pb, Cd, Zn, AC polarography, pulse polarography

LO 6 : Study about principle, instrumentation, Hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltametry.

Andhra University
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M.Sc. (Final) Chemistry Syllabus for 4th Semester
Specialization - *Analytical Chemistry*
Paper - IV: Instrumental Methods of Analysis -II
(Effective from 2021-2022 Admitted batch)

Unit – I:
Atomic Spectroscopy - I

Atomic Absorption Spectroscopy(AAS): theory-atomic line width, line broadening, sample introduction techniques-nebulization, electrothermal, ***direct insertion, hydride generation laser ablation,*****sputtering,** ***arc and spark ablation;*** instrumentation-flame AAS and non-flame / furnace AAS, **atomization techniques**: flame, electrothermal, **glow- discharge atomization**, **hydride atomization**, **cold-vapour atomization and** ***Inductively coupled plasma,*** resonance line sources, hollow cathode lamp, sensitivity and detection limits in AAS, chemical and spectral interferences, applications with special reference to analysis of trace metals in oils, alloys and toxic metals in drinking water and effluents

Unit – II:
Atomic Spectroscopy – II

(a)Flame photometry: principle of flame photometry, theory, instrumentation, combustion flames, detectors, and analysis of Na, K, Ca, Mg, Li

(b)Inductively coupled plasma Emission spectroscopy and Inductively coupled plasma Mass spectrometry (ICP-AES, ICP-MS): principle of AES, instrumentation, plasma, AES detectors, quadrupole mass spectrometers, difference between the two detectors, analysis methods for liquids and solids, applications in the analysis of trace and toxic metals in water, geological and industrial samples.

Unit – III
Thermal methods of Analysis

(a) Thermo gravimetry-theory, instrumentation, applications with special reference to $CuSO_4.5H_2O$, $CaC_2O_4.2H_2O$, $CaCO_3$, $(COOH)_2\ 2H_2O$
(b) Differential thermal analysis-principle, instrumentation, difference between TG and DTA - applications with special reference to the clays and minerals, coals (fuels)
(c)Differential scanning calorimetry-principle, instrumentation, applications to inorganic materials like chlorates and per chlorates, ammonium nitrate, organic compounds and Drugs.

Unit- IV :
Electro analytical Methods of Analysis - I

(a) Voltametry and polarographic analysis : Classification of voltametry**,** principle of polarography, residual current, migration current, diffusion current, half-wave potential,

Ilkovic equation, instrumentation, Dropping mercury electrode (DME), advantages and disadvantages of DME, DC polarography, AC polarography, Pulse polarography-Nornalpulse,triangular pulse and squarewave pulse; qualitative and quantitative analysis of inorganic ions-Cu, Bi, Pb, Cd, Zn, AC polarography, pulse polarography

(b) Anode stripping voltametry: principle, instrumentation, Hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltametry.

(c) Coulometric analysis: principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I^- and S^{2-} by using I_2 liberations and Ce^{4+} liberation in solutions

Unit – V

Electro Analytical and Radio chemical methods of analysis - II

(a) Ion Selective Electrodes: reference electrodes - hydrogen electrode, calomel electrode, silver chloride electrode; indicator electrodes – hydrogen and glass electrodes, theory of membrane potentials and liquid junction potentials, types of ion selective electrodes, basic properties, potentials and construction, calibration of ion selective electrodes, ion selective electrodes with fixed membrane sites, silver, lead, cadmium, sulfide, fluoride, cyanide and glass electrodes, applications in the analysis of air and water pollutants, principles of liquid membrane, gas sensing and enzyme based electrode

(b) Radio chemical methods of analysis: detection and measurement of radioactivity, introduction to radioactive tracers, applications of tracer technique, isotope dilution analysis - applications, activation analysis – application, advantages and disadvantages, radio carbon dating technique

Text Books:

1. Instrumental methods of analysis – H.H Willard, Meritt Jr. and J.A Dean
2. Principles of instrumental analysis – Skoog and West
5. Vogels Textbook of Quantitative Inorganic analysis – J. Basset, R.C Denney, G.H Jefferey and J.Madhan
6. Instrumental methods of analysis – B.K Sarma, Goel Publishing House, Meerut
7. Instrumental methods of Analysis – Chatwal and Anand
8. Instrumental methods of Analysis – Ewing

Reference Books:

W.Wendtlandt, Thermal Analysis, John Wiley Sons, New York

M.Sc. DEGREE EXAMINATION (Model Question Paper)

M.Sc.(Final) Chemistry - 4th semester

Specialization – ANALYTICAL CHEMISTRY

Paper IV –INSTRUMENTAL METHODS OF ANALYSIS -II

Time: Three Hours **Maximum: 80 marks**

SECTION - A

Answer ALL Questions (5 x 16 = 80 marks)

1. (a) i) Give the construction of Hallo cathode lamp and explain its working.

ii) Explain the different types of interferences involved in AAS and give methods to avoid them.

Or

(b) i) Write a short note on types of atomisation devices used in AAS

ii) Explain the instrumentation of non-flame AAS

2. (a) i) Explain the theory and applications of flame photometry in analysis of Alkali and alkali-earth metals.

ii) Write a short note on AES detectors.

Or

(b) i) Write the theory and instrumentation of ICP - AES

ii) Explain the application of ICP – MS in in the analysis of trace and toxic metals in water.

3. (a) i) What are the factors effecting TG curves?

ii) Give principle and instrumentation of DTA

Or

(b) i) How DSC is useful for the analysis of drugs?

ii) Discuss the principle and application of thermo gravimetry for the analysis

of $CuSO_4.\ 5H_2O$, $CaC_2O_4.\ 2H_2O$.

4. (a) i) What are the advantages in DME in Polorography?

ii) Discus the principle and application of anode stripping voltammetry in the analysis of heavy metals in environmental samples.

Or

(b) i) Give the principle involved in Coulometric analysis.

ii) Explain: (a) Half- wave potential and (b) Ilkovic equation.

5. (a) i) Write about calomel electrode and how it is advantageous over hydrogen electrodes?

ii) Discuss the theory of membrane potentials and liquid junction potentials.

Or

(b) i) Give various techniques for measurement of radioactivity.

ii) Give a brief note on (a) Radioactive tracers and applications of tracer technique. (b) Isotopic dilution analysis.

Andhra University
Department of Inorganic and Analytical Chemistry
M.Sc.(Final) Chemistry 4th Semester Syllabus
Specialization - *Analytical Chemistry*
ANALYTICAL CHEMISTRY PRACTICAL – II

(With effect from 2021-2022 admitted batch)

Classical Methods of Analysis-2

1. Water analysis

   (i) Determination of alkalinity (CO_3^{2-}, HCO_3^-) of water samples.
   (ii) Determination of chemical oxygen demand (COD) of drinking water and sewage water
   (iii) Determination of biological oxygen demand (BOD)of drinking water and sewage water

2. Redox titrations
   (i) Determination of oxalate in kidney stones by permanganometric titration.
   (ii) Determination of Fe(II) present in an Iron tablet using $KMnO_4$

3. Fertilizer analysis
   (i) Determination of nitrate from fertilizer
   (ii) Determination of sulfur (as sulfate) from sulfur containing fertilizer.

4. Analysis of oils and soaps
   (i) Determination of saponification value, acid value and iodine value of oil sample
   (ii) Determination of moisture content and total alkali of soaps

5. Separation and determination of ions by ion-exchanger resins
   (i) Determination of Na^+ by cation exchanger resin
   (ii) Determination of Na^+ and K^+ in a mixture by cation exchanger resin
   (iii)Determination of Cl^- and Br^- in a mixture by anion exchanger resin

Instrumental Methods of Analysis-2

1. pH metry
   (i) Determination of purity of commercial H_3PO_4 by pH metric titration
   (ii) Determination of CH_3COOH by pH metric titration.
   (iii)Determination of stability constant of copper glycinate

2. Conductometry
   (i) Determination of a mixture of strong acid and weak acid present in a coloured effluent
   (ii) Determination of sulphate using strong base

3. Potentiometry

(i) Determination of Fe(II) using Mn(VII) of by potentiometric titration
(ii) Determination of Fe (II) using V(V) of by potentiometric titration
(iii) Determination of a mixture of Mn(VII) and V(V) with Fe(II) using potentiometric end point
(iv) Determination of a mixture of bromide and chloride with $AgNO_3$ using potentiometric end point

4. Spectrophotometry

(i) Determination of nitrite in drinking water samples bydiazotization method
(ii) Determination of nitrate -phenoldisulphonic acid method
(iii) Simultaneous Determination of Cr(VI) and Mn(VII) in a mixture without separation
(iv) Determination of Cu(II) using EDTA – Photometric titration method.

5. Flame photometry

(i) Determination of Lithium by flame photometry
(ii) Determination of calcium from milk samples using flame photometry

6. Thin layer chromatography

(i) Separatation and identification of the given mixture of colourless compounds (Diphenylamine, Benzophenone and Naphthalene)
(ii) Separatation and identification of the given mixture of coloured compounds (azobenzene, hydroxyazobenzene, p-aminoazobenzene).

References:

1. A Text Book of Quantitative Inorganic Analysis (3rd Edition) – A. I. Vogel