DEPARTMENT OF CHEMISTRY

ACHARYA NAGARJUNA UNIVERSITY

MEETING OF THE BOS (PG) CHEMISTRY

Held on 29-09-2021

Vide Ref: No. ANU/Acad/Annual PG BoS meeting/2021 dated 09-09-2021.

ACHARYA NAGARJUNA UNIVERSITY

Members of Board of Studies for P.G. (Chemistry) & Forensic Science Syllabus Framing as per CBCS Pattern

			Signature & Date
1	Chairperson	Dr. B. Hari Babu, Associate Professor & HoS Chemistry (PG), Dept. of Chemistry, ANU	23/9/24
2	Internal Members:-	1. Dr. D. Ramachandran, Associate Professor, Dept. of Chemistry, ANU	
		2. Dr. M. Siddha Rao, Associate Professor, Dept. of Chemistry, ANU.	
		3. Dr. R. Ramesh Raju, Assistant Professor & Co-ordinator, Dept. of Chemistry, ANU.	23.9.24
3.	Members from Other University:-	1. Prof. C. Suresh Reddy, Dept. of Chemistry, SV University, Tirupathi.	
		2. Prof. Y. Rami Reddy, Dept. of Chemistry, SV University, Tirupathi.	
4.	Member from Affiliated Colleges:-	1. Dr. V. Madhava Rao, Dept. of Chemistry, Bapatla Engineering College, Bapatla	29/09/2024
5.	Members from Industries:-	1. Dr. D. Sreenivasa Rao, Nutrisign Innovations, Vijayawada.	
		2. Dr. G. Trimurthulu, Lila Impex, Vijayawada	
6.	Ex-Officio Members:-	1. Dr. R.K. Surin, Director, APFSL, Mangalagiri, A.P.	
		2. Dr. M. Srinivasa Reddy, The Chairperson, Bos (U.G.) in Chemistry, ANU.	
		3. Prof. A. Vasudevar Rao, The Dean, Faculty of Physical Sciences, ANU	
7.	Students:-	1. Sri J. Gowri Shankar, Organic Chemistry, ANU Campus.	
		2. Sri Sk. Parveen, Inorganic Chemistry, ANU Campus	
8.	Other Members Attended:-	1. Miss. A. Lathu Dept. of Chemistry, ANU.	
		2. Dr. K. Babu Murali Krishna Dept. of Chemistry, ANU.	

Course Curriculum for PG Programme
2 - Year M.Sc. in Chemistry and 2 - Year M.Sc. Forensic Science

Name Program	**M.Sc.**
Department offering the Programs	**1. Analytical Chemistry** **2. Inorganic Chemistry** **3. Organic Chemistry** **4. Forensic Science**

Distribution of Total Credits			
Course	**Departmental Core (DC)**	**Electives (CE/OE)**	**Total Credits**
Analytical Chemistry	**92**	**16**	**108**
Inorganic Chemistry	**92**	**16**	**108**
Organic Chemistry	**92**	**16**	**108**
Forensic Science	**92**	**16**	**108**

Distribution of Credits: Semester-Wise (Excluding other electives)					
Course	**Semester I**	**Semester II**	**Semester III**	**Semester IV**	**Total**
Analytical Chemistry	**25**	**25**	**24**	**26**	**100**
Inorganic Chemistry	**25**	**25**	**24**	**26**	**100**
Organic Chemistry	**25**	**25**	**24**	**26**	**100**
Forensic Science	**25**	**25**	**24**	**26**	**100**

* CE-Core Elective;
* OE – Other Elective

M.Sc. CHEMISTRY

[with effect from the academic year 2021-22 Under CBCS system]

Semester –I (Analytical, Inorganic and Organic Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Foundation for Chemistry	4	4	30	70	3 hours
2	Inorganic Chemistry	4	4	30	70	3 hours
3	Organic Chemistry	4	4	30	70	3 hours
4	Physical Chemistry	4	4	30	70	3 hours
5	Practical-I - Inorganic Chemistry	3	6	22	53	3 hours
6	Practical-II - Organic Chemistry	3	6	22	53	3 hours
7	Practical-III - Physical Chemistry	3	6	22	53	3 hours
	Total	25	34	186	439	

Semester –II (Analytical, Inorganic and Organic Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Essential Lab Techniques for Industry	4	4	30	70	3 hours
2	Inorganic Chemistry	4	4	30	70	3 hours
3	Organic Chemistry	4	4	30	70	3 hours
4	Physical Chemistry	4	4	30	70	3 hours
5	Practical-I - Inorganic Chemistry	3	6	22	53	3 hours
6	Practical-II - Organic Chemistry	3	6	22	53	3 hours
7	Practical-III - Physical Chemistry	3	6	22	53	3 hours
	Total	25	34	186	439	

Semester –III (Analytical Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Principles and Techniques in Classical Analysis	4	4	30	70	3 hours
2	Applied Inorganic Analysis	4	4	30	70	3 hours
3	Analysis of Applied Industrial Products	4	4	30	70	3 hours
4	Optical, Thermal and Radiochemical Methods of Analysis (CE-I)	4	4	30	70	3 hours
5	*Applications of Synthetic Products (OE-I)*	*4*	*4*	*30*	*70*	*3 hours*
6	Practical-I - Classical Methods of Analysis	4	9	30	70	9 hours
7	Practical-II - Instrumental Methods of Analysis	4	9	30	70	9 hours
	Total	24	34	180	420	

Semester –IV (Analytical Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Advanced Methods of Analysis	4	4	30	70	3 hours
2	Analysis of Drugs, Foods, Dairy Products & Biochemical Analysis	4	4	30	70	3 hours
3	Environmental Chemistry and Analysis	4	4	30	70	3 hours
4	Separation Techniques and Electro Analytical Techniques (CE-II)	4	4	30	70	3 hours
5	*Forensic Science - In Solving Crime (OE-II)*	*4*	*4*	*30*	*70*	*3 hours*
6	Practical-I - Classical & Instrumental Methods of Analysis	4	9	30	70	9 hours
7	Practical-II- Project Work/Review of Literature/Spectral Problems	4	--	--	100	9 hours
8	Comprehensive Viva-voce	2	--	--	50	---
	Total	26	25	150	500	
	All Semester Total Marks (Excluding other Core subjects)	100	127	702	1798	
				2500		

*CE - core Elective
OE - other Elective

2/11/21

Dr.B.HARI BABU, M.Sc., Ph.D.
CHAIRMAN, BOS IN CHEMISTRY (PG)
Acharya Nagarjuna University
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Semester –III (Inorganic Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Advances in Inorganic Chemistry	4	4	30	70	3 hours
2	Physical Inorganic Chemistry	4	4	30	70	3 hours
3	Instrumental Methods in Inorganic Analysis	4	4	30	70	3 hours
4	Bio-Inorganic Chemistry (CE-I)	4	4	30	70	3 hours
5	*Applications of Synthetic Products (OE-I)*	*4*	*4*	*30*	*70*	*3 hours*
6	Practical-I - Classical Methods of Analysis	4	9	30	70	9 hours
7	Practical-II - Instrumental Methods of Analysis	4	9	30	70	9 hours
	Total	**24**	**34**	**180**	**420**	

Semester –IV (Inorganic Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Photo Inorganic Chemistry	4	4	30	70	3 hours
2	Physical Methods in Structural Studies	4	4	30	70	3 hours
3	Instrumental Methods in Inorganic Analysis and Separation Methods	4	4	30	70	3 hours
4	Environmental Chemistry (CE-II)	4	4	30	70	3 hours
5	*Forensic Science - In Solving Crime (OE-II)*	*4*	*4*	*30*	*70*	*3 hours*
6	Practical-I - Classical Methods of Analysis	4	9	30	70	9 hours
7	Practical-II- Project Work/Review of Literature/Spectral Problems	4	--	--	100	9 hours
8	Comprehensive Viva-voce	2	--	--	50	---
	Total	**26**	**25**	**150**	**500**	
				2500		

Semester –III (Organic Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Organic Spectroscopy-I	4	4	30	70	3 hours
2	Organic Synthesis & Reaction Mechanisms-I	4	4	30	70	3 hours
3	Alkaloids, Terpenoids, Quinones and Phenothiazines	4	4	30	70	3 hours
4	Chemistry of Natural Products-I (CE-I)	4	4	30	70	3 hours
5	*Applications of Synthetic Products (OE-I)*	*4*	*4*	*30*	*70*	*3 hours*
6	Practical-I - Multistage Organic Synthesis	4	9	30	70	9 hours
7	Practical-II - Organic Estimations	4	9	30	70	9 hours
	Total	**24**	**34**	**180**	**420**	

Semester –IV (Organic Chemistry)

S. No.	Title of the Paper	No. of Credits	Hours per week	Max. Marks: 100		Exam Time (Hours)
				Internal	External	
1	Organic Spectroscopy-II	4	4	30	70	3 hours
2	Organic Synthesis & Reaction Mechanisms-II	4	4	30	70	3 hours
3	Chemistry of Antibiotics and Drugs	4	4	30	70	3 hours
4	Advanced Organic Chemistry (CE-II)	4	4	30	70	3 hours
5	*Forensic Science - In Solving Crime (OE-II)*	*4*	*4*	*30*	*70*	*3 hours*
6	Practical-I - Analysis of Binary Organic Mixture	4	9	30	70	9 hours
7	Practical-II - Project Work/Review of Literature/Spectral Problems	4	--	--	100	9 hours
8	Comprehensive Viva-voce	2	--	--	50	---
	Total	**26**	**25**	**150**	**500**	
				2500		

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ACHARYA NAGARJUNA UNIVERSITY

M.Sc. FIRST YEAR CHEMISTRY

Effective for the students admitted from the year 2021-2022

SEMESTER – I

Paper-I: Foundation for Chemistry (CH101T)

Marks: 70

Learning Objectives:

- ✓ To know the fundamentals in analytical & inorganic estimations.
- ✓ To know the possible intermediates formed during course of chemical reactions.
- ✓ To know the type of bonding in organic molecules.
- ✓ To know about molecular symmetry, molecular representations and their applicational aspects.

UNIT-I **10H**

Titrimetric analysis: Acid-base titrations, redox titrations, complexometric titrations, precipation titrations-principle, example and corresponding indicators, Pri., Sec.-standards.

UNIT-II **10H**

Treatment of analytical data: Errors, classification, accuracy, precision, SD, MD, Student-T test F-test, Gassian distributation

UNIT-III **14H**

Reactive Intermediates: Generation, Structure, Stability and reactivity of Carbocations, Carbanions, free radicals, Carbenes, nitrenes and Benzyne; Electrophiles, Nucleophiles, Catalysts-definition and examples.

Nature of bonding in organic molecules: Localised and Delocalized covalent bonds, Delocalised chemical bonding conjugation, cross conjugation, hyper conjugation, tautomerism.

UNIT-IV **14H**

Symmetry and Group theory in Chemistry - Symmetry elements, symmetry operation, definition of group, suib group, relation between order of a finite group and its sub group. Point symmetry group. Schonfiles symbols, representation of groups by Matrices (representation for the Cn, Cnv, Cnh, Dn etc. groups to be worked out, explicitely). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use. Application of group theory in IR and Raman spectroscopy.

UNIT-V **12H**

Environmental chemistry:

Classification of environmental segments, types of pollutions, acid rains, Global warming

Chemistry of Biomolecules: Definition, functional uses and examples for Carbohydrates, lipids (fats and oils), enzymes. Chemistry of purines and pyrimidines, Nucleic acids - Structure and functions of DNA & RNA.

Reference Books:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).

Learning Outcomes:

- ✓ The student will understand the required tools in analytical and inorganic estimations.
- ✓ Understanding of various types of reaction intermediates and the bonding present in various organic compounds.
- ✓ Students are able to understand the basics on various environmental concerns.
- ✓ Students know about types of various biomolecules and their functions with reference to structure.

ACHARYA NAGARJUNA UNIVERSITY
M.Sc. FIRST YEAR CHEMISTRY
Effective for the students admitted from the year 2021-2022
SEMESTER – I
PAPER–II: INORGANIC CHEMISTRY (CH102T)

Marks: 70

Learning Objectives:

- ✓ To know the fundamentals in VSEPR theory.
- ✓ To know the Crystal field theory.
- ✓ To know the Molecular Orbital Theory.
- ✓ To know the Hard and Soft Acids and Bases and Macro Cyclic complexes.
- ✓ To know the higher boranes, Isopoly and heteropoly anions.

UNIT-I **12H**

Structure and Bonding: VSEPR theory and its role in explaining the structures of inorganic molecules. Walsh diagrams for linear molecule (Be H_2) and bent molecule (H_2O). Molecular Orbital theory - Symmetry of Molecular orbitals, Molecular orbitals in triatomic (Be H_2) molecules and ions (NO_2^-) and energy level diagrams.

Participation of p and d orbitals in pπ - dπ bonding- Evidences from both non transition and transition metal compounds.

Non-valence cohesive forces, Hydrogen bonding - Symmetric and unsymmetric hydrogen bonds in inorganic molecules.

UNIT II **12H**

Metal-Ligand Bonding: Crystal Field Theory of bonding in transition metal complexes Splitting of d-orbitals in Octahedral, tetrahedral, trigonal bipyramidal and Square pyramidal fields and energy orders of orbitals.

Tetragonal distortions - Jahn Teller effect. Static and dynamic Jahn -Teller effects. Chelates and Jahn - Teller effect

Spectrochemical series. Nephelauxetic effect. Calculation of crystal field stabilization energies. Factors affecting crystal field splitting energies. Applications and limitations of CFT.

UNIT III **12H**

Molecular Orbital Theory - Evidence for covalence in complexes - Experimental evidences from both σ and π bonded 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 Δ_o. Experimental evidence for π-bonding in complexes .

MOT and Resonance. Resonance in homoatomic molecules (H_2) and hetero atomic ions.

Molecular Orbital Theory and Hybridization. Bents Rule and energetic of Hybridization.

UNIT IV **12H**

Metal–Ligand Equilibria in Solutions: Step wise and over all formation constants .Trends in stepwise constants, statistical effect and statistical ratio. Determination of formation constants by Spectrophotometric method (Job's method) and Limitations to Jobs method. Determination of formation constants by pH metric method (Bjerrum's method).

Stability correlations and Irwing -William's series for transition metal ions.

Hard and soft acids and bases (HSAB) – Acid-base strength and HSAB , Electro negetivity and HSAB.

Macrocyclic complexes - Crown ethers and Cryptates.

UNIT V **12H**

Non Metal Cages and Ring Compounds: Preparation and structures of higher boranes, Electron counting rules in boranes – Wades rules and Polyhedral skeletal electron pair theory. Heterocyclic inorganic ring systems Boron-Nitrogen (B-N), Phosphorus–Nitrogen (P-N) and Sulphur-Nitrogen (S-N) cyclic compounds.

Cage compounds of Phosphorous-Oxygen (P-O) and Phosphorous-Sulphur (P-S).

Preparation and structures of Isopoly and heteropoly anions and their sats.

Reference Books:

1) Inorganic Chemistry Huheey, Harper and Row.
2) Physical methods in Inorganic Chemistry, R.S. Drago. Affiliated East-West Pvt. Ltd.
3) Concise Inorganic Chemistry, J. D. Lee, ELBS.
4) Modern Inorganic Chemistry, W. L. Jolly, McGrawHill.
5) Inorganic Chemistry, K. F. Purcell and J. C. Kotz Holt Saunders international.
6) Concepts and methods of inorganic chemistry, B. E. Douglas and D.H.M.C. Daniel.
7) Introductory Quantum mechanics , A. K. Chandra
8) Quantum Chemistry, R. K. Prasad.
9) Inorganic Chemistry, Atkins, ELBS.
10) Advanced Inorganic Chemistry, Cotton and Wilkinson, Wiley Eastern.
11) Quantum Chemistry, R. K. Prasad.
12) Concise Coordination Chemistry, R.Gopalan and V.Ramalingam.

Learning Outcomes:

- ✓ The student will understand the VSPER theory, symmetric and unsymmetric Hydrogen bonds in inorganic molecules.
- ✓ Understanding the Crystal field theory and Jahn Teller Effects.
- ✓ The Students are able to understand the basics of molecular orbital theory and energetic of hybridization.
- ✓ The Students are able to understand the Jobs method, hard and soft acids and bases.
- ✓ The Students are able to understand the study of age compounds of oxygen, phosphorous and sulphar compounds and also isopoly and heteropoly anions.

ACHARYA NAGARJUNA UNIVERSITY

M.Sc. FIRST YEAR CHEMISTRY

Effective for the students admitted from the year 2021-2022

SEMESTER – I

Paper-III: Organic Chemistry (CH103T)

Marks: 70

Learning Objectives:

- ✓ To Know about Aromaticity in Benenoid compounds and Non-Benzenoid compounds.
- ✓ To know about basics on heterocyclic compounds, their synthesis and importance.
- ✓ To know the importance of natural products, their medicinal use.
- ✓ To know particularly about terpenoids and their classification and synthesis.
- ✓ To discuss stereochemistry more elaborately.
- ✓ To know about the conformations of acyclic, monocyclic and fused ring systems.

UNIT-I **12H**

Aromaticity Benzenoid & Non-Benzenoid: Concept of aromaticity, Huckel's rule for aromaticity in benzenoid compounds, Aromaticity of five membered, six membered rings and fused systems.

***Non benzonoid aromatic compounds*:** Cyclopropenyl cation, Cyclobutadienyl dication, cyclopentadienyl anion, tropyllium cation and cyclooctatetraenyl dianion. Ferrocene. Azulenes, Fulvenes, Annulenes, Fullerenes. Homo aromaticity, and Anti aromaticity.

UNIT-II **12H**

Heterocyclic Compounds and Natural Products:

a) Synthesis, Properties and Reactions of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole; Skraup synthesis, Fisher indole synthesis.
b) Heterocyclic compounds more than one hetero atom- synthesis, properties and reaction of Pyrazole, Imidazole, Oxazole Iso-Oxazole, Thiazole.

Natural Products: Importance of natural products as drugs.

Terpenoids: General methods in the structure determination of terpenes. Isoprene rule. Structure determination and synthesis of α-terpeniol, β-carotene, and camphor.

UNIT-III **12H**

Stereochemistry

a) *Molecular representations of organic molecules* –Wedge, Fischer, Newman and Saw-horse formulae, their description and inter-conservation. Stereoisomerism-Definition, classification.
b) *Concept of Chirality and Molecular Symmetry*: Symmetry operations, Recognition of symmetry elements (Cn, Ci and Sn), Dissymmetric and asymmetric molecules. Chiral structures (one and more than one chiral centers); D-L and R–S nomenciature, diastereoisomerism; Threo and Erythro isomers, Racemic mixture, racemization and methods of resolution, stereo specific and stereoselective synthesis. Stereochemistry of compounds containing nitrogen, sulphur and phosphorous.

c) **Geometrical isomerism**– E,Z- nomenclature –Spectral and chemical methods of determining the configuration of geometrical isomers. Determination of configuration in aldoximes and ketoximes.

UNIT-IV **12H**

Conformational Analysis-I

a) *Conformation of acyclic molecules* –alkanes and substituted alkanes (Ethane and 1,2-disubstituted ethane derivatives like butane, dihalobutane halohydrin, ethylene glycol, butane-2,3-diol, amino alcohols and 1,1,2,2-tetrahalobutanes). Klyne-Prelog terminology for conformers and torsion angles.

b) Factors affecting the conformational stability and conformation equilibrium-Attractive and Repulsive interactrions. Use of Physical and Spectral methods in conformational analysis.

c) Conformational effects on the stability and reactivity of diastereomers in cyclic molecules-steric and stereo electronic factors-examples.

UNIT-V **12H**

Conformational Analysis-II

a) *Conformations of monocyclic compounds*–cyclohexane -chair, boat and twist boat cyclohexanes, energy profile diagram –mono- and di- substituted cyclohexanes–conformations. Effect of conformation on stability and reactivity in mono and disubstituted cyclohexane derivatives.

b) *Conformations of unsaturated acyclic compounds*: Propylene, and 1-Butene

c) *Elementary treatment of fused and bridged ring systems* –Decalines and Bornanes. Conformation of sugars. Steric strain due to unavoidable crowding.

Reference Books:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).
6) Stereo Chemistry of carbon compounds – E.L. Eliel.
7) Modern organic Reactions, H.O. House, Benjamin.
8) An introduction to chemistry of Heterocyclic compounds, R.M.Acheson.
9) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
10) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
11) Reaction Mechanism in Organic Chemistry, S.M.Mukherji and S.P.Singh, Macmillan.
12) Basic Principles of Organic Chemistry by J. B. Roberts and M. Caserio.
13) Stereo Chemistry of Organic compounds, P. S. Kalsi, New Age International pubs.

Learning Outcomes:

- ✓ Students can able to understand aromaticity in Benenoid compounds and Non-Benzenoid compounds.
- ✓ Students are able to understand formation of various heterocyclic compounds and their synthesis and importance.
- ✓ Students can understand the importance of natural products in medicinal chemistry
- ✓ Students can able to write the stereo chemical forms for different organic molecules.
- ✓ Understand the conformations of acyclic, monocyclic and fused ring systems and applying it to organic compounds.

ACHARYA NAGARJUNA UNIVERSITY
M.Sc. FIRST YEAR CHEMISTRY
Effective for the students admitted from the year 2021-2022
SEMESTER-I
PAPER-IV: Physical Chemistry (CH104T)

Marks: 70

Learning Objectives:

- ✓ To know the first and second law of thermo dynamics.
- ✓ To know the surface tension, Gibbs-Adsorption, X- ray flouresence and Augar electron spectroscopy.
- ✓ To know the micelles - Hydrophobic interaction.
- ✓ To know the Nernst equation and Debye Huckel - Onsagar equation.
- ✓ To know the complex reactions, Collision theory and chain reactions.

UNIT-I **12H**

Thermodynamics–I: Classical thermodynamics - Brief review of first and second laws of thermodynamics - Entropy change in reversible and irreversible processes - Entropy of mixing of ideal gases - Entropy and disorder - Free energy functions – Gibbs - Helmoboltz equation - Maxwell partial relations - Conditions of equilibrium and spontaneity - Free energy changes in chemical reactions: Van't Hoff reaction isotherm - Van't Hoff equation - Classiuss Clapeyron equation - partial molar quantities - Chemical potential - GibbsDuhem equation - partial molar volume - determination of partial molar quantities - Fugacity - Determination of fugacity - Thermodynamic derivation of Raoult's law.

UNIT II **12H**

Surface Phenomena and Phase Equilibria: Surface tension - capillary action - pressure difference - across curved surface (young - Laplace equation) - Vapour pressure of small droplets (Kelvin equation) - Gibbs-Adsorption equation - BET equation - Estimation of surface area - catalytic activity of surfaces – ESCA , X- ray flouresence and Augar electron spectroscopy.

UNIT III **12H**

Surface Active Agents: Classification of surface active agents - Micellisation - critical Micelle concentration (CMC) - factors affecting the CMC of surfactants, microemulsions - reverse micelles - Hydrophobic interaction.

UNIT-IV **12H**

Electrochemistry-I: Electrochemical cells - Measurement of EMF - Nernst equation - Equilibrium constant from EMF Data - pH and EMF data - concentration cells with and without transference - Liquid junction potential and its determination - Activity and activity coefficients - Determination by EMF Method - Determination of solubility product from EMF measurements. Debye Huckel limiting law and its verification. Effect of dilution on equivalent conductance of electrolytes - Anamolous behaviour of strong electrolytes. Debye Huckel-Onsagar equation - verification and limitations - Bjerrum treatment of electrolytes - conductometric titrations.

UNIT-V **12H**

Chemical Kinetics: Methods of deriving rate laws - complex reactions - Rate expressions for opposing, parallel and consecutive reactions involving unimolecular steps. Theories of reaction rates - collision theory - Steric factor - Activated complex theory - Thermodynamic aspects - Unimolecular reactions - Lindemann's theory - Lindemann-Hinshelwood theory. Reactions in solutions - Influence of solvent - Primary and secondary salt effects - Elementary account of linear free energy relationships - Hammet - Taft equation - Chain reactions - Rate laws of H_2-Br_2, photochemical reaction of H2 - Cl2 Decomposition of acetaldehyde and ethane - Rice-Hertzfeld mechanism.

Reference Books:

1) Physical Chemistry P.W. Atkins, ELBS
2) Chemical Kinetics - K.J.Laidler, McGraw Hill Pub.
3) Text Book of Physical Chemistry. Samuel Glasstone, Mcmillan Pub.
4) Physical Chemistry, G.W.Castellan. Narosa Publishing House
5) Thermodynamic for Chemists. Samuel Glasstone
6) Electrochemistry, Samuel Glasstone, Affiliated East West
7) Physical Chemistry, W.J. Moore, Prentice Hall
8) Atomic structure and chemical bond. Manas Chanda. Tata McGraw Hill Company Limited.

Learning Outcomes:

- ✓ Students can able to understand the classical thermo dynamics, fugacity.
- ✓ Students are able to understand Kelvin equation, Gibbs-Adsorption equation - BET equation.
- ✓ Students are able to understand the Classification of surface active agents.
- ✓ Students are able to understand the Electrochemical cells, Liquid junction potential.
- ✓ Understand the complex reactions, chain reactions.

Course: M.Sc.; Specializations: Analytical, Inorganic, and OrganicChemistry

Practical Syllabus (Semester: I; Batch: 2021-22)

Practical – I: Inorganic Chemistry

(Minimum five experiments must be carryout) Max. Marks: 53 (43Prac. & 5Viva + 5Rec.)

Quantitative Analysis

List of Experimetns:

1) Determination of Zn2+ with potassium ferrocyanide (Volumetric).
2) Complexomatric titrations: Determination of Mg 2+, Ni2+ and hardness of water using EDTA.
3) Determination of Fe3+ by photochemical reduction.
4) Argentometry: Determination of chloride by argent metric titration using.
   a) K2CrO4 (b) Fluorescein as indicators.
5) Determination of nickel using dimethyl glyoxime.
6) "Cupper using ammonium thiocyanate".
7) Zn using di ammonium hydrogen phosphate – gravimetrically.
   (Minimum two Gravimetric experiments).

Reference Books:

1) Vogels Text Books of Quantitative analysis, Revised. J. asset, R.C. Denny, G.H. Jeffery and J. Mendhan. ELBS.
2) Synthesis and Characterisation of Inorganic Compounds, W.L. Jolly. Prentice Hall.
3) Practical Inorganic chemistry by G. Pass and H. Sutcliffe Chapman and Hall.
4) Practicle Inorganic Chemistry by. K. Somasekhar Rao and K.N.K. Vani.

Course: M.Sc.; Specializations: Analytical, Inorganic, and OrganicChemistry

Practical Syllabus (Semester: I; Batch: 2021-22)

PRACTICAL-II: Organic Chemistry

(Minimum five experiments must be carryout) Max. Marks: 53 (43Prac. & 5Viva + 5Rec.)

List of Experiments:

1) One step & Two step Organic compounds preparation – Yield of crude and crystallized samples and reporting of the melting point/Boiling points.
   Preparations: i) Iodoform ii) n-Dinitroderivative iii) Asprin iv) p-Nitroaniline v) Bezophenone vi) Benzoic acid vii) p-Bromo Acetanilide viii) Acetanilide ix) any other organic compound.
2) Purification of organic compound- The student has to do Recryastallization to final compound(s) (for both steps) and submit the sample.
3) Distillation of Alcohol, Toluene.
4) Chromatography- The student has to submit purity of the final product with TLC
5) Chromatographic separation of impurities by TLC.
6) Student should practice solvent extraction methods.

Course: M.Sc.; Specializations: Analytical, Inorganic, and OrganicChemistry
Practical Syllabus (Semester: I; Batch: 2021-22)

Practical – III: Physical Chemistry

(Minimum five experiments must be carryout) Max. Marks: 53 (43Prac. & 5Viva + 5Rec.)

List of Experimetns:

1) Determination of rate constant of the oxidation of iodide ion with persulphate ion.
2) Relative strengths of acids by studying the hydrolysis of ethylacetate / methyl acetate.
3) Determination of equilibrium constant of KI3 ↔ KI + I2 by partition coefficient method and determination of unknown concentration of potassium iodide.
4) Distribution coefficient of Benzoic acid between Benzene and water.
5) Determination of critical solution temperature of phenol-water system Study of the effect of eletrolyteon the miscibility of phenol-water system.

ACHARYA NAGARJUNA UNIVERSITY

M.Sc. FIRST YEAR CHEMISTRY

Effective for the students admitted from the year 2021-2022

SEMESTER – II

Paper-I: Essential Lab Techniques for Industry (CH201T)

Marks: 70

Learning Objectives:

- ✓ To know the fundamentals in separation analysis using various chromatographic techniques.
- ✓ To know the techniques involving reliable separation by HPLC & GC instrumental techniques.
- ✓ To know the purification by ion exchange chromatography.
- ✓ To know the instrumentation and applications of AAS & ICP-OES.
- ✓ To know the basic principles, instrumentation and advantages UV, IR, NMR, ESR, TEM, SEM- techniques in structural analysis.

UNIT-I **14H**

Chromatography – Adsorption and Partition

1) **Introduction to Chromatography.** Different types of Chromatography. Adsorption chromatography- adsorbents, solvents, solutes, apparatus. Column Chromatography- stationary phase, Mobile phase, packing of column, advantages and disadvantages.
2) **Thin Layer Chromatography:** Basic Principles. Common stationary phases, Methods of preparing TLC plates, Selection of mobile phase, Development of TLC plates, Visualization methods, R_f value. Application of TLC in monitoring organic reactions.
3) **Paper Chromatography:** Basic Principles. Ascending and descending types. Selection of mobile phase, Development of chromatograms, Visualization methods. Application of paper chromatography in the identification of sugars and amino acids. One and two dimensional paper paper chromatography.

UNIT-II **14H**

High Performance liquid chromatography (HPLC): Basic Principles. Normal and reversed Phases. Selection of column and mobile phase. Instrumentation. detectors; RT values. Applications in the separation, identification and quantitative estimation of organic compounds. Concepts on HPLC method development.

UNIT-III **12H**

Gas Chromatography: Basic Principles. Different types of GC techniques. Selection of columns and carrier gases. Instrumentation. detectors; RT values. Applications in the separation, identification and quantitative analysis of organic compounds.

Ion Exchange Chromatography: Basic Principles. Preparation of cross linked polystyrene resins. Different types of cation and anoin exchange resins. Application in the purification of carboxylic acids and amines.

UNIT-IV **10H**

AAS: Principle, instrumentation and applications

ICP-OES: Principle, instrumentation, applications and advantages over AAS.

UNIT-V **10H**

UV, IR, NMR, ESR, TEM, SEM-Basic principles, instrumentation and advantages.

Reference Books:

1) Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman, Harcourt College Pub.
2) Separation Techniques by M. N. Sastri, Himalaya Publishing House (HPH), Mumbai.
3) Bio Physical Chemistry by A. Upadhyay, K. Upadhyay and N. Nath, (HPH) , Mumbai.
4) A Hand Book of Instrumental Techniques for Analytical Chemistry- Ed-F. A. Settle, Prearson Edn.,
5) Delhi. Introduction to Organic Laboratory Techniques-D. L. Pavia, G. M. Lampman, G. S. Kriz and R. G. Engel, Saunders College Pub. (NY).
6) Instrumental methods of Chemical Analysis by B. K. Sharma, Goel Publish House, Meerut.
7) Instrumental methods of Chemical Analysis by H. Kaur, Pragati Prakasan, Meerut.

Learning Outcomes:

- ✓ The student will understand advantage of cheromatographic separation and application on various reactions.
- ✓ The student will understand the advantage of HPLC & GC techniques over conventional separation techniques.
- ✓ The student will know the exchange of ions taking place in ion exchange chromatography.
- ✓ The student will know the procedure of analysing the elements using AAS & ICP-OES.
- ✓ The students understand the working principles and advantages of the UV, IR, NMR, ESR, TEM, SEM- techniques.

ACHARYA NAGARJUNA UNIVERSITY
M.Sc. FIRST YEAR CHEMISTRY
Effective for the students admitted from the year 2021-2022
SEMESTER – II
PAPER-II: INORGANIC CHEMISTRY (CH202T)

Marks: 70

Learning Objectives:

- ✓ To know the Classification and Applications of Metal Clusters.
- ✓ To know the reactions of organo metallic compounds.
- ✓ To know the Anation Reactions and Trans effects.
- ✓ To know the Selection rules, Correlation diagrams and Orgel diagrams.
- ✓ To know the Cotton effect and Faraday effect, structures of Hemoglobin and Myoglobin, Vitamin B_{12}, Photo Chemical Laws.

UNIT-I **12H**

Metal Clusters Classification: LNCs and HNCs**,** Isoelectronic and Iso lobal relationships, electron counting rules: Wade's and Lauher's rules. M-M multiple bonding; Preparation, structure and bonding in di nuclear $[Re_2Cl_8]^{2-}$, tri nuclear $[Re_3Cl_9]$, tetra nuclear $[W_4OR_{16}]$ and hexa nuclear $[Mo_6Cl_8]^{4+}$, $[Nb_6Cl_{12}]^{2+}$ cluster molecules and ions.

Poly atomic Zintle ions and Chevrel phases. Applications of clusters

Metal π-Complexes Preparation, structure and bonding in Nitrosyl, Dinitrogen and Dioxygen complexes.

UNIT II **12H**

Organometallic Complexes of Transition Metals: Classification and electron counting rules. Metallocenes with four, five, six, seven and eight (η^4 - η^8) membered rings. Synthesis, structure and bonding of Ferrocene. Cyclopenta dienyl, Arene, Cyclohepta triene and Tropylium complexes of transition metals.

Reactions of organometallic compounds - oxidative addition, reductive elimination, insertion and elimination.

Applications of organometallic compounds - Catalytic hydrogenation, Hydroformylation and polymerization of olefin using Zeigler- Nutta catalyst.

UNIT III **12H**

Reaction Mechanism in Transition Metal Complexes: Kinetics of octahedral substitution, acid hydrolysis, base hydrolysis - conjugate base (CB) mechanism. Direct and indirect evidences in favour of CB mechanism.

Anation Reactions: Reactions without metal- ligand bond cleavage. Factors affecting the substitution reactions in octahedral complexes. Trans effect on substitution reactions in square planar complexes.

Mechanism of redox reactions, outer sphere mechanism, cross reactions and Marcus –Hush equation, inner sphere mechanism, complementary and non - complementary reactions.

UNIT IV **12H**

Electronic Spectra of Transition Metal Complexes: Electronic configurations of metal ions and Spectroscopic terms. Selection rules, Breakdown of selection rules, Slator – Condon repulsion parameters, Racah parameters, Term separation energies for d^n electronic configurations.

Correlation diagrams and Orgel diagrams. Tanabe-Sugano diagrams for configurations from d^1 to d^9 octahedral and tetrahedral transition metal complexes of 3d series.

Calculations of Dq, B and β parameters. Charge transfer spectra.

UNIT V **12H**

Magnetic Properties of Transition Complexes: Types of magnetism, anomalous magnetic moments - Orbital and spin contribution, spin - orbit coupling and magnetic moments. Chiroptical properties, Cotton effect and Faraday effect.

Biochemical aspects of iron and cobalt: Binding, storage and transport of dioxygen by Hemoglobin and Myoglobin, Vitamin B_{12} and its importance.

Photo Inorganic Chemistry: Introduction, Photochemical laws, photo redox reactions and photo anation reactions. Photo chemical decomposition of water.

Reference Books:

1) Inorganic Chemistry, Huheey. Harper and Row.
2) Concise Inorganic Chemistry, J. D. Lee, ELBS.
3) Inorganic chemistry, K.F. Purcell and J.C. Kotz, Holt Saunders international
4) Organometallic chemistry, R.C. Mehrotra and A. Singh. New Age International.
5) Advanced Inorganic Chemistry ,Cotton and Wilkinson, Wiley Eastern
6) Inorganic Reaction Mechanism, Basolo and Pearson, Wiley Eastern
7) Bioinorganic Chemistry, K. Hussan Reddy
8) Biological Aspects of inorganic chemistry , A. W. Addiso, W. R. Cullen, D. Dorphin and G. J. James. Weliey Interscience.
9) Photochemistry of coordination compounds, V.Balzaniand V.Carassiti. Academic Press.

Learning Outcomes:

- ✓ The student will understand the various metal clusters and metal $\boldsymbol{\pi}$ complexes.
- ✓ Understanding the reactions of organo metallic compounds and its applications.
- ✓ The Students are able to understanding the reaction mechanism in transition metal complexes, anation reactions, and complementary reactions.
- ✓ The Students are able to understand the orgel diagrams and electronic spectra of transition metal complexes.
- ✓ The study of magnetic properties and anamolous magnetic moments of transition complexes.
- ✓ The Students are able to understanding structure and functions of hemoglobin, myoglobin and vitamin B12, photochemical laws.

ACHARYA NAGARJUNA UNIVERSITY

M.Sc. FIRST YEAR CHEMISTRY

Effective for the students admitted from the year 2021-2022

SEMESTER – II

Paper-III: Organic Chemistry (CH203T)

Marks: 70

Learning Objectives:

- ✓ To know the general methods of synthesis involving carbon-carbon multiple bonds
- ✓ To know various mechanisms involved in aliphatic and aromatic Nucleophilic/electrophilic substitution reactions
- ✓ To know about various elimination mechanisms in different types of substrates
- ✓ To know the importance of functional group protection in organic synthesis
- ✓ To know the mechanisms involved in various types of named reactions and their applications in organic synthesis.

UNIT-I **12H**

General Methods for synthesis: Addition reactions involving electrophiles (Br_2, HBr, HOBr, and H_2O/H_2SO_4); nucleophilic additions (Michael addition, Mannich, and Grignard reactions); Addition to C-C multiple bonds -stereo chemistry of addition, formation and reactions of epoxides, syn and anti hydroxylation; hydrogenation (catalytic and Non catalytic).

UNIT-II **12H**

Aliphatic Nucleophilic substitutions: The SN_2, and SN_1: Mechanisms, energy profile diagram and stereochemistry; SNi, mixed SN_1 & SN_2, and SET mechanisms; Factors influencing nucleophilic substitution reactions: Effect of structure, nucleophile, solvent, and leaving group.
The neighbouring group mechanism: Neighbouring group participation by O, N, S, halogens, in nucleophilic substitution reactions. Concept of classical and Non-classical carbocations-Participation of Pi and Sigma bonds as neighbouring groups. Anchimeric assistance-steric requirement.

UNIT-III **12H**

Aromatic Nucleophilic Substitutions: The SNAr, SN1 mechanisms and benzyne mechanism. Reactivity- effect of substrate structure, leaving group and attacking nucleophile. The Von-Ritcher, Sommelet – Hauser and Smiles rearrangements.

Aromatic Electrophillic Substitution reactions -Friedel Crafts Alkylation, Acylation, Halogenations.

UNIT-IV **12H**

Elimination and Protecting Groups:

a) Types of elimination (E1, E1CB, E2) reactions, mechanisms, stereochemistry and orientation, Hofmann and Saytzeff's rules, Syn elimination versus anti elimination. Competitions between elimination and substitution.
b) Dehydration, dehydrogenation, decarboxylative elimination, pyrolytic elimination, molecular rearrangement during elimination.

c) **Importance of functional group protection in organic Synthesis:** Protecting agents for the protection of functional groups- Hydroxyl group, Amino group, Carbonyl group and Carboxylic acid group.

UNIT-V **12H**

Familiar Named Reactions: Benzoin, Perkin, Cannizaro, Dieckmann and Stobbe condensations; Hofmann, Schmidt, Lossen, Curtius, Clasien, Backmann and Fries rearrangements; Reformatsky, Favoursky, Wittig reaction, Baeyer Villiger reaction and Chichibabin reaction, Oppenaur oxidation, Clemmensen, Wolff-Kishner, Meerwein–Ponndorf–Veriey and Birch reductions.

Reference Books:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).
6) Stereo Chemistry of carbon compounds – E.L. Eliel.
7) Modern organic Reactions, H.O.House, Benjamin.
8) An introduction to chemistry of Heterocyclic compounds, R.M.Acheson.
9) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
10) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
11) Reaction Mechanism in organic chemistry, S.M.Mukherji and S.P.Singh, Macmillan.

Learning Outcomes:

- ✓ Students understand the mode of addition reactions involving addition by electrophile and nucleophiles over unsaturated bonds between carbons
- ✓ Students understand and apply the substitution and elimination reaction mechanisms at aliphatic and aromatic substrates for various reactions leading to research
- ✓ Understand how to protect various functional groups in organic synthesis and can apply the same to novel molecules useful for research also.
- ✓ Students understand the mechanisms of studied named reactions and their applications in organic synthesis.

ACHARYA NAGARJUNA UNIVERSITY
M.Sc. FIRST YEAR CHEMISTRY
Effective for the students admitted from the year 2021-2022
SEMESTER-II
PAPER-IV: Physical Chemistry (CH204T)

Marks: 70

Learning Objectives:

- ✓ To know the Third law and Statistical thermodynamics and Nernst Heat theorem, Entropy and probability.
- ✓ To know the classification of polymers, molecular weights determination.
- ✓ To know the Butler-Volmer equation, polarography and Amperometric titrations.
- ✓ To know the Hydrogen-oxygen reaction, Quantum yield and Stern - Volmer equation.
- ✓ To know the hydrolysis of ATP, thermodynamics of biopolymer solutions.

UNIT-I **12H**

Thermodynamics II: Third law and Statistical thermodynamics-Nernst Heat theorem - Third law of thermodynamics - Its limitations - Determination of absolute entropy - concept of distriction - Thermodynamic probability and most probable distribution - Ensemble-ensemble averaging - Maxwell-Boltzmann distribution law - Partition function - Fermi-Dirac statistics - Bose Einstein statistics - Entropy and probability - Boltzmann-Plank equation - calculation of thermodynamic properties in terms of partition function - Application of partition function - Chemical equilibrium and partition function - Translational, rotational and electronic partition function - Entropy of Monoatomic gases (Sackur - Tetrode equation).

UNIT II **12H**

Polymer Chemistry: Classification of polymers - Free radical, ionic and Zeigler -Natta Polymerisation - kinetics of free radical polymerisation - Techniques of polymerisation - 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 **12H**

Electro Chemistry II: Electrode potentials - Double layer at the interface - rate of charge transfer - Decomposition potential - Over potential - Tafel plots - Derivation of Butler - Volmer equation for one electron transfer - electro chemical potential. Electro catalysis - - Fuel cells- Theory of polarography - Diffusion current - Ilkovic equation - Equation for half- wave potential – Applications of polarography - Amperometric titrations -Corrosion - Forms of corrosion - prevention methods.

UNIT-IV **12H**

Chemical Kinetics: Branching Chain Reactions - Hydrogen-oxygen reaction - lower and upper explosion limits - Fast reactions - Study of kinetics by flow methods - Relaxation methods - Flash photolysis - Acid base catalysis - protolytic and prototropic mechanism - Enzyme catalysis.

Photo Chemistry: Quantum yield and its determination - Actinometry - Reactions with low and high quantum yields - Photo sensitisation - Exciplexes and Excimers - Photochemical equilibrium – Chemieluminescence - Kinetics of collisional quenching-Stern - Volmer equation - Photo Galvanic cells.

UNIT-V **12H**

Biophysical Chemistry: Standard free energy change in biochemical reactions, exergonic and endergonic reactions, hydrolysis of ATP, thermodynamics of biopolymer solutions, chain configuration of bio polymers, calculation of average dimensions. Membrane equilibrium, ion transport through cell membrance, dialosis and its function. Structure and functions of proteins, enzymes, DNA and RNA in living systems, forces involved in bio polymer interactions, electrostatic forces, hydrophobic forces, molecular expansion and dispersion forces.

Reference Books:

1) Physical chemistry, G.K. Vemulapalli (Prentice Hall of India).
2) Physical chemistry, P.W. Atkins. ELBS
3) Chemical kinetics - K.J. Laidler, McGraw Hill Pub.
4) Text book of Physical Chemistry, Samuel Glasstone, Macmillan pub.
5) Statistical Thermodynamics - M.C. Gupta.
6) Polymer Science, Gowriker, Viswanadham, Sreedhar
7) Elements of Nuclear Science, H.J. Arniker, Wiley Eastern Limited.
8) Quantitative Analysis, A.I. Vogel, Addison Wesley Longmann Inc.
9) Physical Chemistry-G.W. Castellan, Narosa Publishing House, Prentice Hall
10) Physical Chemistry, W.J. Moore, Prentice Hall
11) Polymer Chemistry - Billmayer
12) Fundamentals of Physical Chemistry, K K Rohatgi-Mukherjee. Wiley Eastern Limited Publications.
13) Statistical Thermodynamics - M.Dole.
14) M.N. Hughes, The Inorganic chemistry of Biological Processes, John Wiley and Sons, New York 2nd Edition, 1981.
15) A text book of Biochemistry, AV.S.S. Rama Rao.
16) Physical Chemistry by Atkenes.

Learning Outcomes:

- ✓ Students understand the Third law of thermodynamics, Maxwell-Boltzmann distribution law and Sackur - Tetrode equation.
- ✓ Students understand the Free radical, ionic and Zeigler -Natta Polymerisation.
- ✓ Students understand the Butler - Volmer equation and Ilkovic equation.
- ✓ Students understand the Branching Chain Reactions, Enzyme catalysis and Photochemical equilibrium.
- ✓ Students understand the free energy change in biochemical reactions, exergonic and endergonic reactions, DNA and RNA in living systems in biopolymer interactions.

Course: M.Sc.; Specializations: Analytical, Inorganic, and Organic Chemistry
Practical Syllabus (Semester: II; Batch: 2021-22)

Practical – I: Inorganic Chemistry

(Minimum five experiments must be carryout) Max. Marks: 53 (43Prac. & 5Viva + 5Rec.)

Qualitative Analysis

Semimicro analysis of six radical mixtures containing one interfering radical and one less familiar cation each.

Interfering anions : Oxalate, tartrate, phosphate, chromate.

Less familiar Cations : Thallium, molybdenum, thorium, zirconium,vanadium, uranium.
(Minimum three Mixtures)

Reference Books:

1) Vogels Text Books of Qualitative analysis, Revised. J. asset, R.C. Denny, G.H. Jeffery and J. Mendhan. ELBS.
2) Synthesis and Characterisation of Inorganic Compounds, W.L.Jolly. Prentice Hall.
3) Practical Inorganic chemistry by G. Pass and H. Sutcliffe Chapman and Hall.
4) Practical Inorganic Chemistry by. K. Somasekhar Rao and K.N.K. Vani.

Course: M.Sc.; Specializations: Analytical, Inorganic, and Organic Chemistry
Practical Syllabus (Semester: II; Batch: 2021-22)

PRACTICAL-II: Organic Chemistry

(Minimum five experiments must be carryout) Max. Marks: 53 (43Prac. & 5Viva + 5Rec.)

1) Identification functional groups in organic compounds: Phenol, bases, organic acid, ketone, aldehyde, amide and carbohydrate with preparation of two solid derivatives.
   i) Identification of given two compounds with preparation of two solid derivatives and reporting of the melting points for derivatives.
2) Purification of derivatives- The student has to do Recryastallization to final derivatives(s) and submit the sample. If the sample is impure liquid must carryout distillation process.

Course: M.Sc.; Specializations: Analytical, Inorganic, and Organic Chemistry
Practical Syllabus (Semester: II; Batch: 2021-22)

Practical – III: Physical Chemistry

(Minimum five experiments must be carryout) Max. Marks: 53 (43Prac. & 5Viva + 5Rec.)

List of Experiments:

1) Potentiometric determination of Fe(II) with Cr (VI)
2) Potentiometric titration of chloride with silver nitrate.
3) pH-metric determination of strong acid with strong base.
4) Conductometric titration of strong acid with strong base
5) Verification of Beers Law using potassium permanganate.
6) Verification of Beers Law using Potassium dichromate.
7) Determination of formulae and stability constant of a metal complex by spectro photometric method.
8) Verification of Langmuir isotherm. Determination of unknown concentration of acetic acid by studying its adsorption on activated charcoal.

SEMESTER – III

(Paper-I: Organic Spectroscopy-I)

Learning Objectives

- To learn about the basics of various spectroscopic techniques
- To understand the instrumentation of UV, IR, NMR, ESR spectroscopic techniques.
- To apply the spectroscopy knowledge for the structural elucidation of organic molecules

UNIT	TITLE	HRS	Marks
I	**UV-Vis spectroscopy:** a) UV spectroscopy: Energy transitions – Simple chromophores – UV absorption of Alkenes – polyenes unsaturated cyclic systems – Carbonyl compounds, α,β- unsaturated carbonyl systems - Woodward Fieser rules – aromatic systems – solvent effects – geometrical isomerism – acid and base effects – typical examples – calculation of λ_{max} values using Woodward-Fieser rules. b) ORD: Theory of optical rotatory dispersion, α-Axial haloketone rule and octant rule – Application of these rules in the determination of absolute configuration of cyclohexanones, decalones and cholestanones. c) Circular Dichroism : Principle – positive and negative cotton effects – Absolute configuration	12	14
II	FT-IR: Infrared spectroscopy : Fundamental modes of vibrations – Stretching and bending vibrations – overtones, combination bands and Fermi resonance, factors influencing vibrational frequencies, hydrogen bonding – finger print region and its importance – Study of typical group frequencies for – CH, -OH, -NH, -CO-NH_2, -CC, -CHO, -CO and aromatic systems - Application in structural determination –Simple problems	12	14
III	^{1}H NMR spectroscopy: a) Magnetic properties of Nuclei, Nuclear resonance, Fourier Transformation and its importance in NMR. Equivalent and non-equivalent protons, The chemical shift and its importance, calculation of chemical shift, factors affecting the chemical shifts such as electronegativity and anisotropy, effect of deuteration, Signal integration, Spin-spin coupling: vicinal (Karplus relationshps), germinal and long range. Coupling constants (*J*) and factors affecting coupling constants. – Shielding and deshielding mechanisms in acetylene carbonyl and Benzene, anisotropy – Spin-Spin Interactions related to first order and higher order spectra (AB, A_2; AB_2, ABX, ABC, AMX) – temperature dependence spectra, Hydrogen bonding. Nuclear Overhauser effect (NOE). b) Interpretation of NMR spectrum of a given compound leading to identification –typical examples of PMR spectroscopy.	12	14

IV	**ELECTRON SPIN RESONANCE SPECTROSCOPY(ESR)**:- a) Basic Principles, Comparison of NMR & ESR. Determination of 'g' value, Factors affecting the 'g' value. Isotropic and Anisotropic constants. Splitting, hyper fine splitting coupling constants. Line width, Zero field splitting and Kramer degeneracy. Crystal field splitting, Crystal field effects. b) Applications:- Detection of free radicals; ESR spectra of (a) Methyl radical ($CH_3^{\cdot}$), (b) Benzene anion ($C_6H_6^-$)	12	14
V	**Common Problem on UV-Vis, FT-IR and ^{1}H NMR** (a) Problems involving individual spectral methods – UV, IR and PMR (b) Problems involving combined any two of UV, IR and PMR (c) Problems involving all the three of UV, IR and PMR.	12	14
	Course Outcome: Students can understand the fundamentals of spectroscopic techniques and apply to investigate the structural information of molecules. It can provide a platform to get the awareness towards UV, FTIR, Raman, 1H NMR and Mass Spectrometry which aims to apply these knowledge towards research.		

References:

1. Spectrometric identification of organic compounds by R.N. Silverstein & G.C. Bassier (John Willey)
2. Spectroscopic methods in Organic Chemistry by Williams and Fleming (Mcgraw Hill)
3. "Organic Photochemistry" by R.O.Kan (Mc Graw Hill)
4. " Advanced organic Chemistry Reaction Mechanisms and Structure" by J March (Mc Graw Hill & Kogshusha)

SEMESTER – III

(Paper-II: Organic Synthesis & Reaction Mechanisms-I)

Unit	Title	Hours	Marks
I	**Methods for Reaction Mechanism by Kinetic & Non-Kinetic studies** **Kinetic studies**: Kinetics of reaction, Energy profile diagram, Intermediate versus transition state, Reaction rate and rate limiting step. **Non-Kinetic studies** Identification of products, testing possible intermediates, trapping of intermediates, Cross over experiments, Isotopic labeling.	12	14
II	**Free Radicals** Free radicals and their reactions-Introduction to radical reactions, Addition of halogens, Hydrogen halides. Substitution reactions-Halogenation, Aromatic substitution, Sandmayer reaction, Autooxidation, Decomposition of dialkyl and diacyl peroxides.	12	14
III	**Oxidations** Introduction: Different Oxidative processes. Hydrocarbon: alkenes, aromatic rings saturated C-H groups (activated and unactivated), Alcohols, diols, aldehydes, Ketones, Carboxylic acids, Amines, hydrazines, sulphides. Oxidations with ruthenium tetroxide iodobenzene diaccetate and Tl(III) nitrate, Lead tetra acetate, SeO_2, MnO_2 Ag_2CO_3, peracids. Oxidation of C=C perhydroxylation using $KMnO_4$, OsO_4, peracids.	12	14
IV	**Reductions** Introduction: Reductive process Hydrocarbons: Alkanes, alkenes, alkynes, and aromatic rings Carbonyl compounds – aldehydes, ketones, acids and their derivatives. Nitro, nitroso, azo and oxime group Hydrogenolysis. Catalytic hydrogenations, Reduction by dissolving metals, Reduction with metal and acid. Reduction with metal in liquid ammonia (Birch reduction). Reduction by hydride transfer reagents Aluminium alkoxide, LiAlH4, NaBH4, Diisobutyl aluminium hydrides –Sodium cyano borohydride ,tryalkyl borohydirdes – Reduction with diimide.	12	14
V	**Asymmetric Synthesis-I** **Terminology:** Topocity in molecules Homotopic, stereo Heterotopic (enantiotopic and diastereotopic) groups and faces- symmetry, substitution and addition criteria. Prochirality nomenclature: Pro-R, Pro-S, Re, and Si. **Selectivity in synthesis:** Stereo specific reactions (substrate stereoselectivity). Conditions Stereo selective reactions (product	12	14

	stereoselectivity): Enantio selectivity and dia stereoselectivity.: **Analytical methods:** % Enantiomer excess, optical purity, % diastereomeric excess.		

SEMESTER – III

(Paper-IIII: Alkaloids, Terpenoids, quinines and Phenothiazines)

UNIT	TITLE	HOURS	MARKS
I	**Alkaloids-I:** a) Alkaloids: Definition, General methods of identification of alkaloids- nomenclature – occurrence – isolation –-chemical tests for identification -general methods of structural elucidation – degradation – classification based on nitrogen heterocyclic ring –role of alkaloids in plants. a) Structure and synthesis of Atropine, Caffeine b) Quinoline alkaloids: Chemistry and synthesis of Quinine, Cinchonine, and their stereochemistry	12	14
II	**Alkaloids-II** a) ISOQUINOLINE-MORPHINE GROUP ALKALOIDS: Papaverine, Hydrastine, narcotine, canadine, Coclawrine, Morphine, Codeine, emetine, Apomorphine, Glaucine b) Stereochemistry of emetine, and morphine alkaloids. c) Biogenesis of alkaloids	12	14
III	**Alkaloids-III** (1) Indole alkaloids : Reserpine, strychnine, brucine, lysergic acid, erogotamine (2) Structure, stereochemistry, synthesis and biosynthesis of Ephedrine, Conine and nicotine.	12	14
IV	**Terpenoids:** Terpenoids: Classificaiton , sources , isolation, synthesis and stereochemistry with special reference to zingiberene, santonin, eudesmol, abietic acid., Biosynthesis of terpenoids	12	14
V	**Quinones and Phenothiazines** **Quinones:** Identification of quinones, Lapachol. Chrysophenol and Physcion-chemistry and synthesis. **Phenothiazines**: Classification, pharmacological properties of phenothaizines, general methods of synthesis of phenothiazines with reference to Promazine, Prochlorperazine and Thioriazine	12	14
	References: 1. Alkaloids by K.W.Bentley Vols I & II. **2.** Text Book of Organic Chemistry I.L.Finar Vol.II 3.An introduction of alkaloids by G.A.Swain, **3. Books for further Study:** 1. Chemistry and physiology of alkaloids by Manske Vol.I & II, VII 2. Medicinal Chemistry by A. Burger 3. Isoquinoline Alkaloids by M.Shamma 4. Heterocylclic Chemistry by JA Joule etal, Chapman – Hall 5. An introduction to heterocyclic compounds by RM Acheson, John –		

	Wiley 6. Non-Antibiotics – A new class of unrecognized antimicrobics by AN Chakraborthy etal, National Institute of Science Communication, (CSIR), New Delhi, India, 1988 7. Principles of Medicinal Chemistry by William O.Foye, Lea & Febiger, Philadelphia/London, 1989		

SEMESTER –III

(Paper-IV: Chemistry of Natural Products-I) (ELE-I)

UNIT	TITLE	HOURS	MARKS
I	**Flaronoids** Classificaiton,sources, isolation,chemistry and synthesis with special reference to quercetin and kampferol	12	14
II	**Vitamins** **Fat Soluble Vitamins**: Chemistry,Synthesis & biosynthesis of vitamin A_1,vitamin E(α,β,γ,δ-tocopherols) and vitamin K **Water soluble Vitamins**: Chemistry,Synthesis and biosynthesis of B_1 and C	12	14
III	**Steroidal Hormones** Chemistry & synthesis of equilenine, oestrone, progestrone, androsterone, testosterone, cartisone. **Non steroid hormones**: Chemistry & synthesis of thyroxin, epinephrine and oxytocin	12	14
IV	**Amino acids:** Classification of amino acids. Specific methods of preparations –Malonic ester synthesis, and Erlenmeyer azalactone synthesis. Isoelectric point. **Proteins:** General nature of proteins – annealing, Biuret reaction, Ninhydrin test. Classification of proteins. Merrified solid phase peptide synthesis. Primary, secondary, tertiary and quaternary structure of proteins. a)Enzymes : classification, kinetics and mechanism of enzyme action b) Coenzymes and cofactors: NAD FAD folic acid citric acid cycle. c) Prostaglandins with special reference to PGE and PGF	12	14
V	**Insecticides** **Naturally occuring insecticides**: Introduction, general properties, sources, isolation,synthesis and stereochemistry of Pyrethrin I and II; Jasmolin I & II; Strucutre activity relation ship (SAR) studies and bio synthesis of pyrethrins **Rotenoids** – Chemistry and synthesis of rotenone **Isobutylamines:** Chemistry and sysnthesis anacyclin, spilanthol **Minor insecticides of plant origin**: pachyrrhizin and custard-apple.	12	14

SEMESTER –III

(Paper-V: Other Elective) (ELE-II)

UNIT	TITLE	HOURS	MARKS
I	**Dyes:** Colour and constitution, classification, dyeing method and their industrial importance. **Drugs:** Basic concepts, classification, sources, the requirement of an ideal drug. -	12	14
II	**Synthetic Drugs:** Structure and medicinal properties. **Sulphanilamide** – An example of sulpha drug - paracetamol, aspirin, oil of wintergreen; Mephensin. A muscle relaxant; Ibuprofen – an anti-inflammatory drug; L-dopa-cures Parkinson's disease;	12	14
III	**Soaps and Detergents:** Production and their cleansing action. Liquid crystals and their applications. Surfactants **Cosmetics:** Detailed study of formulations and manufacturing of cream and lotions, lipstick and nail polish, shampoos, hair dyes and tooth pastes. **Flavours:** Natural flavouring materials and classification.	12	14
IV	**Sweeteners:** Natural and Synthetic sweeteners. **Pesticides:** Introduction, Classification, Applications and their effect on environment. **Insecticides:** Introduction, Classification, Applications and their effect on environment. **Explosives:** Introduction, RDX, Gun Powder.	12	14
V	**Polymers:** Introduction, biodegradable and non-biodegradable polymers and their industrial importance, plastics (uses and effects on environment), natural and synthetic rubbers, polyamides and poly esters like nylon, decron, terelyne. Thermoplastics – Poly carbonates, Poly acrylates in lens applications, Polyurethanes and conducting polymers.	12	14

References:

1. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.742.
2. K. Albert, L Lehninger, D. L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ Publishers, 1st Edition, New Delhi, 1993.
3. Harper's Biochemistry, Ed. R. Harper, 22nd Edition, Prentice Hall Press, New York, 1990.
4. Encyclopedia of Chemical Technology – Kirck – Othmer Series.

5. Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer & V.W. Rodfwell, 15th Edition, Maurzen Asian Edition, California, 1981.
6. Polymer Science, Gowarikar.
7. Industrial Chemistry, B.K. Sharma.

SEMESTER –IV

(Paper-I: Organic Spectroscopy-II)

UNIT	TITLE	HOURS	MARKS
I	**^{13}C NMR Spectroscopy:** Types of 13C nmr spectra: undecoupled, proton- decoupled, single frequency off-resonance decoupled (SFORD) and selectively decoupled spectra. Signal enhancement by Nuclear OVER HAUSER effect. ^{13}C chemical shifts, factors affecting the chemical shifts. Noise decoupled and off-resonance spectra of simple Compounds. Calculation of chemical shifts of alkanes, alkenes and alkynes. Typical examples of CMR spectroscopy – problems.	12	14
II	**Mass Spectroscopy:** Introduction, principles of ionization methods: EI, CI, FDI, PDI, LDI, FAB, TSI and ESI, Types of mass analyzers; Types of fragments- odd electron and even electron containing neutral and charged species (even electron rule), nitrogen rule, molecular-ion peak, base peak, metastable ion, isotopic abundance. High Resolution-MS (HRMS), index of hydrogen deficiency (IHD). Fragmentation of typical organic compounds - hydrocarbons, aromatics, alcohols, alkyl halides, ethers, Carbonyls, carboxylic acids, esters, amines, amides, nitro compounds. General methods of mass spectral fragmentation- β-cleavage, Mclafferty rearrangement, retro Diels-Alder fragmentation and ortho effect. Factors affecting fragmentation– Mass spectra related problems.	12	14
III	**2D NMR Techniques:** Principles of 2D NMR, classification of 2D-experiments, 2D-J-resolved spectroscopy. Correlation spectroscopy (COSY), HOMO COSY (^{1}H-^{1}H COSY), COSY of *m*-dinitrobenzene, isopentyl acetate, Hetero COSY (1H, ^{13}C COSY) Hetero COSY of isopentyl acetate and 4-methyl-2-pentanol, HMQC, HMQC of codeine, long range ^{1}H, ^{13}C COSY (HMBC), HMBC of codeine and NOESY, NOESY of 9-benzylanthracene, 2-D INADEQUATE experiments.	12	14
IV	**Spectral characteristics of natural products involving all spectral data**: Use of spectroscopic methods UV, IR, 1H and 13C–NMR and Mass spectra in the structure elucidation of natural products. Illustration with suitable compounds like Apigenin(Flavone), Kaempferol (flavonol), Umbelliferone (coumarin), Camphor (Terpenoid), Lawsone (Naphthoquinone), Papaverine (Alkaloid) and Equilenine (steroid).	12	14

V	**Spectral Problems:** Applications of ^{13}C NMR spectroscopy: Stereochemistry, and reaction mechanisms. Applications of ^{1}H NMR spectroscopy: Stereochemistry-Geometrical and optical isomerism. Spectral Problems involving all spectral data UV-Vis. ^{1}H NMR, ^{13}C NMR, Mass spectrometry & 2D NMR techniques	12	14

SEMESTER –IV

(Paper-II: Organic Synthesis & Reaction Mechanisms-II)

UNIT	TITLE	HOURS	MARKS
I	**Formation of C-C single & double bonds and Diels–Aider & related reactions** Formation of C-C single bonds – enamines and related reactions Formation of C-C double bonds – Corey-wimnter olefination, Peterson olefination, Juliy olefination, McMury coupling, witting reaction of Phosphorus ylides –stereoselective synthesis of tri and tetra substituted alkenes. Diels–Aider and related reactions –diene-dienophile, intra molecular Diels –Alder reactions, Stereochemistry and mechanism Retro Diels –Alder reaction –1,3-dipolar reactions.	12	14
II	**Synthetic Strategies or Retero Synthesis** Terminology- Target Molecule(TM), synthon, synthetic equivalent, functional group interconversion (FGI), and representation of disconnection of bonds. Linear and convergent synthesis. One group and two group disconnections in simple molecules- Alcohols, Olefins, aryl ketones, α,β-Unsaturated compounds – 1,3 dicarbonyl compounds. synthesis involving chemoselectivity, regioselectivity, reversal of polarity and cyclizations.	12	14
III	**Photochemistry:** Photochemistry of olefins–conjugated olefins–Aromatic compounds–isomerisation–additions. Photochemistry of carbonyl compounds – Norrish type I and II reactions –Paterno – Buchi Reaction. Photo reduction, Photochemical rearrangements–Photo Fries rearrangement, Di-π-methane rearrangement.	12	14
IV	**Pericyclic reactions**: Definition, classification, MO theory, Electronic configuration in ground and first excited states of aliphatic conjugated polyene system(upto 4 double bonds). **Electrocyclic Reactions**: Mechanism, stereochemistry, PMO, FMO, correlation diagram, Woodward Hoffman rules. **Cycloaddition Reactions**: FMO and correlation diagram methods-(2+2) and (4+2) cycloaddition reactions, stereochemistry. Woodward Hoffman rules. **Sigmatropic Rearrangement**: classification, Mechanism by FMO method, Woodward Hoffman rules. Cope, claisen and Aza-cope rearrangements.	12	14
V	**Asymmetric Synthesis-II** **Substrate controlled asymmetric synthesis:** Nucleophilic additions to chiral carbonyl compounds. 1,2- asymmetric induction, Cram's rule, and Felkin-Anhmodel. i) Chiral auxiliary controlled asymmetric	12	14

	synthesis: Į-Alkylation of chiral Enolates, azaenolates, 1,4-Asymmetric induction and Prelog's rule. Use of chiral auxiliaries in DielsAlder and Aldol reactions. ii) Chiral reagent controlled asymmetric synthesis: Asymmetric reductions using BINAL-H. Asymmetric Hydroboration using IPC2 BH and IPCBH2.		

SEMESTER –IV

(Paper-III: Chemistry of Anitibiotics and Drugs)

UNIT	TITLE	HOURS	MARKS
I	**Antibiotics:** Synthesis of penicillin-G, ampicillin, amoxicillin, chloramphenicol, cephalosporin Streptomycin, tetracyclins, terramycin, aureomycin, gramidin.	12	14
II	**Drugs and Medicinal chemistry:** **Anticancer Agents**: Synthesis & Activity relationship of Taxol, Vinblastine, Vincristine, Campothecin. **CNS stimulants**: Strychnine (CNS activity only), caffeine, Nicotine; CNS depressants, General anesthetics, mode of action of Sedatives & Hypnotics.	12	14
III	**Antimalarials:** Paludrin – quinacrin – chloroquin – camoquin – pamaquin – sontoquine. **Sulpha drugs:** Sulphanilamide – Dihydrocurprine – Prontosil	12	14
IV	**Antiseptics and Antifungal agents** **Antiseptics:** Common types, trichlosan, aminocrine hydrochloride. Antiseptics *Vs* Disinfactants-Properties, Mechanism of action, classification **Antifungal agents:** 1,8 dihyrosxyanthranol – griseofulvin.	12	14
V	**Herbal Drugs**: i) Classification of herbal drugs- Pharmacological and Chemical classification. ii) Adulteration and evaluation of drugs. iii) Different chemical groups of Herbal drugs-- Alkaloids, Terpenoids, Glycosides, Volatile oils, Isolation of volatile oils, Tannins and carbohydrates. iv) Herbal drugs and their therapeutic efficacy. Isolation of- Laxative- Aloe emodin from Aloes. Anti-diabetics- Neem oil (Neem); Anti-malarial- Quinine (cinchona); Anti-hypertensive- Reserpine (rawolfia).	12	14

SEMESTER –IV

(Paper-IV: Advanced Organic Chemistry) (ELE-III)

UNIT	TITLE	HOURS	MARKS
I	**Advanced named reactions in Organic Synthesis:** Baylis-Hillmon reaction, RCM Olefin metathesis, Grubb's catalyst, Mitsunobu reaction, Suzuki Coupling, Heck Coupling, Stille Coupling, Sonagashia, Coupling, Negishi Coupling, Hiyama Coupling, Buchwold – Hartwig Reaction, Click Reaction.	12	14
II	**Nano Chemistry** Introduction, carbon nanotubes: structure of single and multi wall carbon nanotubes, synthesis-solid and gaseous carbon source-based production techniques, synthesis with controlled orientation. Growth mechanism of carbon nanotubes-catalyst free growth, catalyst activated growth, properties-general, adsorption, electronic & optical, Mechanical and reactivity. Applications.	12	14
III	**Green synthesis:** Introduction, Principles, Green solvents- supercritical fluids, water, ionic liquids and PEGs as green solvents for organic reactions. Examples of green reactions-synthesis of Ibuprofen, Clean Fischer-Indole synthesis comparison of the above with conventional methods. **Microwave organic synthesis:** Introduction, Applications: Microwave assisted reactions in- water (oxidation of toluene to benzoic acid, oxidation of alcohols); organic solvents (Diels-Alder reaction and Decarboxylation); solvent-free reactions (solid state reaction)-Michael addition and Knoevenagel reaction), multistep V/s single pot synthesis.	12	14
IV	**Organoboranes** Synthetic applications of organoboranes –protonolysis, oxidation, carbonylation Reaction of alkenylborane –enantioselective synthesis of secondary alcohols from alkenes **Organosilanes :** Synthesis of organosilanes, general features of carbon-carbon bond forming reactions of organosilicon compounds, addition reactions with aldehydes and ketones, acylation reactions, conjugate addition reactions.	12	14
V	**Supramolecular Chemistry**: Introduction-the meaning of supramolecular chemistry, phenomenon of molecular recognition and their quantification Building blocks of supramolecular chemistry- acyclic receptors for neutral and charged guests, macrocycles and crown ethers, macrobicycles and cryptands, macropolycycles, cucurbituril and cyclodextrins.	12	14