Dr. Hari Singh Gour Vishwavidyalaya, Sagar
M.Sc. CHEMISTRY
2023 – 24 (NEP)
SCHEME OF EXAMINATION SEMESTER III

	Course Code	Course Name	Credits
		Discipline Specific	
1	CHE-DSM-321	Spectroscopy and molecular characterization	4
2	CHE-DSM-322	Laboratory course-Inorganic Chemistry	2
3	CHE-DSM-323	Chemistry at the interface with biology and environment	4
4.	CHE-DSM-324	Laboratory course-organic Chemistry	2
		Multidisciplinary	
5	CHE-MDM-321	Chemistry of Materials	4
6	CHE-MDM-322	Laboratory Course: Physical Chemistry	2
		Skill enhancement course (Anyone between 321A or 321B)	
7	CHE-SEC-321A	Organometallic and Supramolecular Chemistry	3
8	CHE-SEC-321B	Heterocyclic Chemistry and Natural Products	3
9	CHE-SEC-322	Laboratory Course - Preparation, Extraction & Analysis	1
		Total Credits:	**22**

Distribution of Marks :

Mid Sem. Exam 20 marks	Internal Assessment 20 marks	Total 40 Marks	End Sem Marks	Total Marks
20	20	40	60	100

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Department of Chemistry
Dr. Harisingh Gour Vishwavidyalaya, Sagar
Scheme of M.Sc. Program in Chemistry under NEP
Objectives and Learning Outcomes of M.Sc. Chemistry

Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-DSM-321	Spectroscopy and molecular characterization	Mid Sem: 40 End Sem: 60	04

Course Objectives: To impart knowledge of spectroscopic techniques and applications.

Course Learning Outcomes: Upon successful learning, students will be able to learn
Unit-I: Knowledge and Applications of Nuclear Magnetic Resonance focused on 1H-NMR spectroscopy.
Unit-II : Concepts of nuclear magnetic resonance spectroscopy for the nucleus other that ^{1}H and ^{13}C and basic concepts and applications of electron spin resonance spectroscopy
Unit-III: Nuclear quadrupole resonance spectroscopy and the Mossbauer Spectroscopy.
Unit-IV: Basics and applications of mass spectrometry.
Unit-V: Concept of Combinatorial Spectroscopy.

Suggested Readings:

- Introduction of Spectroscopy by Pavia
- Spectroscopy of Organic compounds by P.S. Kalsi
- Fundamentals of Molecular Spectroscopy by C.N. Banwell
- Organic Spectroscopy by William Kamp
- Spectrometric Identification of Organic compounds by Robert M. Silverstein, Francis X. Webster
- Modern Spectroscopy by J.M. Hollas
- Organic Spectroscopy by L.D.S. Yadav

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M.Sc. Chemistry, Semester I
CHE-DSM-321
Spectroscopy and Molecular Characterization

Credits :4 — 60 Hrs

UNIT I	**Nuclear Magnetic Resonance Spectroscopy** General introduction and definition, Chemical shift, spin spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto), chemical exchange, effect of deuteration, complex spin – spin interaction between two, three, four and five nuclei (first order spectra), virtual cpoupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra- nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique, nuclear overhauser effect (NOE). Resonance of other nuclei-F, P. **C-13 NMR spectroscopy:** General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy-COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques	12
Unit II	**Nuclear Magnetic Resonance of Paramagnetic Substances in Solutions** The Complex, Contact and Pseudo-contact shifts, factors affecting nuclear relaxation, shift reagents, contrast agents, some applications including biochemical systems and over view of NMR of metal nuclides with emphasis on Pt^{195} & Sn ^{119} NMR. **Electron Spin Resonance Spectroscopy**: Introduction, g-factor, electron-nucleus coupling, hyperfine structure of E.S.R. absorption, double resonance, electron-electron coupling, fine structure, techniques of E.S.R. Spectroscopy.	12
UNIT III	**Nuclear Quadrupole Resonance Spectroscopy** Quadrupole nuclei, quadrupole moments, electric field gradients, coupling constants, splitting, applications **Mossbauer Spectroscopy:** Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structure of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (2) Sn^{2+} and Sn^{4+} compounds – nature of M-L bond, co-ordination number, structure and (3) detection of oxidation states in equivalent MB atoms.	12
UNIT IV	**Mass spectrometry** Introduction, ion production-EI, CI, FD and FAB, Factors affecting fragmentation ion analysis, ion abundance, mass spectral fragmentation of organic compounds of common functional groups. Molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination. **Optical Rotatory Dichroism** [ORD] and Circular Dichorism{CD} Definition, deduction of absolute configuration, octant rule for ketones.	12
UNIT V	**Combinatorial Spectroscopy:** General guidelines for the interpretation of UV-spectra. Characteristic vibrational frequencies of Organic compounds, Characterization of simple organic compounds by combinatorial spectroscopy using methodology for joint application of UV,IR,^{1}H and ^{13}C-NMR and Mass spectral data.	12

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Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-DSM-322	Laboratory course-Inorganic Chemistry	Mid Sem: 40 End Sem = 60	02

Course Objectives: To develop experimental skills of synthetic Inorganic chemistry and methods of characterization of molecules.

Course Learning Outcomes: Upon successful learning, students will be able to learn

a) Synthetic methods for inorganic molecules.
b) Application of spectroscopic techniques for characterization of synthesized molecules.
c) Thermal of and magnetic analysis of Inorganic molecules and their applications.

Suggested Readings:

- Synthesis and characterization of inorganic compounds, W.L. Jolly, Prentice Hall
- J. Chem. Ed., 1988, 65, 1024.
- J. Chem. Educ., 1986, 63, 90.
- J. Chem. Edu., 1986, 63, 90.
- J. Chem. Educ., 1977, 54, 443; 1973, 50, 670.
- Acct. Chem. Res., 1975, 8, 384.
- Inorg. Synth. 1972, 13, 184.
- J. Chem. Soc. Dalton, 1979, 1901, J.Chem.Edu.1982, 59, 1052.
- J. Chem. Edu., 1966, 43, 73, 730.

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M.Sc. Chemistry semester III
CHE-DSM-322
Laboratory Course -Inorganic Chemistry

Credits : 2

Any five experiments suggested below.

S.N.	Experiments	60 Hrs
1.	Synthesis of metal oxalate hydrate. J.Chem.Ed., 1988, 65, 1024. Characterization of metal oxalates	12
2.	Metal complexes of dimethyl sulfoxide: $CuCl_2$.2DMSO, $PdCl_2$.2DMSO, $RuCl_2$.4DMSO. J.Chem.Educ., 1986, 63, 90. Characterization of metal complexes of dimethyl sulfoxide	12
3.	Synthesis of metal acetylacetonate [Co-,Ni-, Cu- etc], : Inorg.Synth, 1957, 5, 130; 1963, 1, 183. Bromination of $Cr(acac)_3$. J.Chem.Edu., 1986, 63, 90. Characterization of metal acetylacetonate including magnetic moment determination.	12
4.	Synthesis of Cis and Trans $[Co(en)_2Cl_2]^+$. ;Characterization of $[Co(en)_2Cl_2]$	12
5.	Preparation of N,N bis(salicyldehyde)ethylenediamine, salen H_2, Co(salen) , Ni-, Cu- etc.] J.Chem.Educ., 1977, 54, 443; 1973, 50, 670. Determination of O_2 absorption by Co(salen). Acct. Chem. Res., 1975, 8, 384. Reaction of oxygen adduct with $CHCl_3$ (deoxygenation). Characterization of N,N bis(salicyldehyde)ethylenediamine, salen H_2, Co(salen) etc.	12
6.	Determination of Cr(III) complexes. $[Cr(H_2O)_6]NO_3.3H_2O$, $[Cr(H_2O)_4Cl_2]Cl.2H_2O$, $[Cr(en)_3]Cl_3$, $Cr(acac)_3$. Inorg. Synth. 1972, 13, 184. Characterization of chromium complexes	12
7	Preparation of Copper glycine complex-cis and trans bis (glycinato Copper (II)). J.Chem.Soc.Dalton, 1979, 1901, J.Chem.Edu.1982, 59, 1052. Characterization of cis- and trans-bis-glycinatocopper(II) complex	12
8	Preparation and use of Ferrocene. J.Chem.Edu., 1966, 43, 73, 730. Derivatization of Ferrocene Characterization of Ferrocene	12

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Objectives and Learning Outcomes of M.Sc. Chemistry

Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-DSM-323	Chemistry at the interface with biology and environment	Mid Sem: 40 End Sem = 60	03

Course Objectives: Biological aspects of Inorganic, Organic and Physical chemistry.

Course Learning Outcomes: Upon successful learning, students will be able to learn
Unit-I: Basic understanding of bioinorganic and bioorganic chemistry.
Unit-II: Chemistry of enzymes and co-enzymes.
Unit-III: Application of physical Chemistry in biological system.
Unit-IV: Application of chemistry in treatment of pollutants of hydrosphere.
Unit-IV: Application of chemistry in treatment of pollutants of lithosphere and atmosphere.

Suggested Readings:

- Principle of Bioinorgainc Chemistry, S. J. Lippard and J.M. Berg.
- Bioinorganic Chemistry by I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Book.
- Bioorganic Chemistry, A chemical approach to enzyme action, Hermann Dugas and C. Penny, Springer-Verlag
- Understanding enzymes, Trevor Palmer, Prentice Hall.
- Principles of Biochemistry, A. L. Lehninger, Worth Publishers
- Biochemistry, L. Stryer, W. H. Freeman.

M.Sc. Chemistry semester III
CHE-DSM-323
Chemistry at the interface with biology and environment

Credits : 4 60 Hrs

UNIT I **Metal ions in biological systems:** Essential and trace metals; Na^+/K^+Pump : Role of metal ions in biological processes. ; Bioenergetics and ATP Cycle 12
DNA binding & polymerisation, glucose storage, Ca- vit D binding; metal complexes in harvesting, storage and transmission of energy.
Chlorophylls: photosystem I and photosystem II in cleavage of water, model systems. Nitrogenase; Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenase model systems.

UNIT II **Introduction of Bioorganic Chemistry:** Basic considerations, proximity effects and molecular adaptation; 12
Enzymes and co-enzymes: Introduction and historical perspective, chemical and biological catalysis. Remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Kosohfand's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site directed mutagenesis, enzyme kinetics, Michaelis and Lineweaver- Burk plots, reversible and irreversible inhibition.
Mechanism of Enzyme Action:-Transition state theory, orientation and steric effect, acid base catalysis, covalent catalysis strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysoztyme and carboxypeptidase A
Co-enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD, NADP, FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofactors

UNIT III **Biophysical Chemistry**: Biological Cell and its constituents; structure and function of proteins, enzymes, DNA and RNA in living systems, Helix coil transition. 12
Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic, Hydrolysis of ATP, Synthesis of ATP from ADP. Statistical Mechanics in Biopolymers, Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures, Polypeptide and protein structures, introduction to protein folding/unfolding problems; docking energies.

UNIT IV **Treatment of Pollutants of Hydrosphere:** Chemical composition of water bodies-lakes, streams, rivers and wet lands etc. Hydrological cycle. Aquatic pollution- inorganic, organic, agricultural, industrial and sewage, detergents, oil spills and oil pollutants, Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, content of chloride, sulphate, nitrate and nitrite, Water quality standards. Analytical methods for measuring metals (As, Cd,Cr,F,Pb,Hg,Se,) Purification and treatment of water 12

UNIT V **Lithosphere and Atmosphere-Pollution** 12
Soils: Composition,; Geochemical, Hydrochemical and Airochemical-causes and impacts; Micro and macro nutrients ; Pollution- fertilizers, pesticides, plastics and metals. Waste treatment.
Atmosphere: Chemical composition of atmosphere- particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N,C,S and their effect.

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-DSM-324	Laboratory course-Organic Chemistry	Mid Sem: 40 End Sem = 60	02

Course Objectives: To develop experimental skills of various separation, purification techniques and structural elucidation of natural products.

Course Learning Outcomes: Upon successful learning, students will be able to learn

a) Isolation and identification of natural products.
b) Estimation of bio-molecules by chemical methods.
c) Multistage organic synthesis and spectroscopic analysis.

Suggested Readings:

- Experimental techniques in Organic Chemistry, D. Pasto, C. Johnson, and M. Miller, Prentice Hall
- Macroscales and microscales organic experiments, K. N. Willianson, D.C. Health
- Vogel's Textbook of Organic Chemistry
- Handbook of organic analysis- Qualitative and quantitative, H. Clarke, Adverd Arnoid
- Systematic qualitative organic analysis, H. Middleton, Adverd Arnold

M.Sc. Chemistry semester III
CHE-DSM-324
Laboratory Course -Organic Chemistry

Credits : 2

S.N.	Experiments	60 Hrs
1.	• Isolation of casein from milk • Isolation of lactose from milk (purity of sugar should be checked by TLC, PC and Rf value reported.); Characterization of the products.	12
2.	• Isolation of cinchonine from cinchona bark. • Isolation of piperine from black pepper. ; Characterization of the products.	12
3.	• Isolation of lycopene from tomatoes. • Isolation of β- carotene from carrots; Characterization of the products.	12
4.	• Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid). • Isolation of (+) limonine from citrus rinds.	12
5.	**Spectrophotometric (UV/VIS) Estimations [Quantitative]** Amino acids, Proteins , Carbohydrates, Cholesterol, Ascorbic acid, Aspirin, Caffeine; **Qualitative tests also.**	12

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Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-MDM-321	Chemistry of Materials	Mid Sem: 40 End Sem = 60	04

Course Objectives: To explore chemistry behind the materials.

Course Learning Outcomes: Upon successful completion of the course, students will be able to understand:
Unit I: preparation and chemical aspects of multiphase materials.
Unit II: Properties, different states and applications of glass, ceramics, composites and nanomaterials.
Unit III: Different aspects (physical, chemical and structural) of liquid crystals.
Unit IV: Materials and their conduction behaviour.
Unit V: Basic aspects of nanochemistry.

Suggested Readings:

- Material Science and Engineering, an introduction, W.D. Callister. Willey
- Materials Science, J.C. Anderson, K.D. Leaver, J.M. Alexander, and R.D. Rawlings, ELBS
- Handbook of liquid crystals, Kelker and Hatz, Chemie Verlag.

M.Sc. Chemistry semester III CHE-MDM-321 Chemistry of Materials and Nanosciences		
Credits : 4		60 Hrs
UNIT I	**Multiphase Materials:** Ferrous alloys; Fe-C phase transformations in ferrous alloys; stainless steels, non-ferrous alloys, properties of ferrous and non-ferrous alloys and their applications. **Thin film and Langmuir-Blodgett Films** :Preparation techniques; evaporation / sputtering, chemicalprocesses, MOCVD, sol-gel etc. Langmuir-Blodgett (LB) Film, growth techniques, photolithography, properties and applications of thin and LB Films.	12
UNIT II UNIT III	**Glasses, Ceramics, Composites and Nanomaterials :** Glassy state, glass former and glass modifiers, applications. Ceramic structures, mechanical properties, clay products. Refractories, characterization, properties and applications. **Microscopic composites**; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties, applications. **Liquid Crystals** :Mesmorphic behavior, thermotrophic liquid crystals, positional order, bond orientational order, nematic and smecticmesophases; smectic–nematic transition and clearing temperature-homeotrophic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals. **Polymeric Materials :** Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behaviour, polymer types and their applications, conducting and ferro-electric polymers	12
UNIT IV	**Organic Solids, Fullerenes, Molecular Devices :** Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes-doped, fullerenes as superconductors. Molecular rectifiers and transistors, artificial synthetic devices, optical storage memory and switches-sensors. **Nonlinear optical materials**: nonlinear optical effects, second and third order-molecular hyperpolarisability and second order electric susceptibility-materials for second and third harmonic generation.	12
UNIT V	**Nanoparticles and Nano- Chemistry:** Nanoparticles, Methods of synthesis of nanoparticles, different reducing agents and stabilizing agents, reactivities and catalytic activities of nanoparticles. Characterization of nanoparticles-techniques. Applications of nanoparticles. Microporous and Mesoporous solids/Zeolites. **Quantum dots and Chemical applications:** Quantum dots, mechanism on the basis of band gap, excitons, quantum confinement effect, Bohr's radius in quantum dots, Different applications.	12

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Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-DSM-325	Laboratory course-Physical Chemistry	Mid Sem: 40 End Sem = 60	02

Course Objectives: To develop experimental skills of various separation, purification techniques and structural elucidation of natural products.

Course Learning Outcomes: Upon successful learning, students will be able to apply
Unit I: Concept of partial molar volumes in binary mixture.
Unit II: Temperature dependence of the solubility of a compound in two solvents
Unit III: Concept of pKa value.
Unit IV: Concept of stability constants.
Unit V: Concept of electronic and IR spectral data.

Suggested Readings:

- Practical Physical Chemistry, A.M. James and F.E. Prechard, Logman.
- Findley's Practical Physical Chemistry, B.P. Levitt, Longlan.
- Experimental Physical Chemistry, R.C. Das, and B. Behera, Tata McGraw Hill.

M.Sc. Chemistry semester III
CHE-DSM-325
Laboratory Course -Physical Chemistry

Credits : 2

UNIT	Experiments	60 Hrs
UNIT I	Determination of partial molar volumes of solute (eg KCL) and solvent in a binary (alcohol+ H_2O) (NaCl + H_2O) mixture .	12
UNIT II	Determination of the temperature dependence of the solubility of a compound in two solvents having similar intramolecular interactions (benzoic acid in water and DMSO – Water mixture) and calculate the partial molar heat of the solution.	12
UNIT III	Determination of pKa of an indicator (eg methyl red) in (a). aqueous and (b) micellar media.	12
UNIT IV	Determination of stoichiometry and stability constant of inorganic complexes (eg. Ferric – salicylate acid) and organic (eg. Amine – iodine) systems. [Spectrophotometry/pHmetry]	12
UNIT V	Characterization of complexes based on Electronic (UV-Vis) and IR spectral data.	12

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-SEC-EC-321A	Organometallic and Supramolecular Chemistry	Mid Sem: 40 End Sem: 60	03

Course Objectives: To learn about synthesis, structure, bonding and application aspects metal-organic framework.

Course Learning Outcomes: Upon successful learning, students will be able to learn

Unit-I: Synthetic, stability and application aspects of metal-alkyls and metal-aryls.

Unit-II: Chemistry of metal-carbon multiple bonds.

Unit-III: Bonding and structural aspects of Pi complexes.

Unit-IV: Role and mechanism of organometallic compounds in catalyzing organic reactions.

Unit-IV: Chemistry and applications of supramolecules.

Suggested Readings:

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

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M.Sc. Chemistry semester III

CHE-SEC-EC-321A

Organometallic and Supramolecular Chemistry

Credits : 3 — 45 Hrs

UNIT I	**Chemistry of transition metal-carbon bond:** Alkyls and Aryls of Transition Metals, Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis	9
UNIT II	**Compounds of Transition Metal-CarbonMultiple Bonds** :Alkylidenes, alkylidynes, low valent carbenes and carbynes-synthesis, nature of bond structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.	9
UNIT III	**Transition Metal π-Complexes :** Transition metal Π-complexes with unsaturated organic molecules, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligiands and to organic synthesis.	9
UNIT IV	**Homogeneous and Heterogeneous catalysis** :Stochiometric reactions for catalysis homogeneous catalytic hydrogenation; Heterogeneous catalysis; Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.	9
UNIT V	**Supramolecular Chemistry:** Concepts and language.Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of co receptor molecules and multiple recognition. Supramolecular reactivity and catalysis, Transport processes and carrier design. **Supramolecular devices**: Supramolecular photochemistry, supramolecular electronic, ionic and switching devices. Some example of self-assembly in supramolecular chemistry.	9

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Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-SEC-EC-321B	Heterocyclic Chemistry and Natural Products	Mid Sem: 40 End Sem: 60	03

Course Objectives: To give the quantitative ideas about the synthesis properties and uses of small and large heterocyclic rings.

Course Learning Outcomes: Upon successful learning, students will be able to
Unit I: learn about nomenclature and chemical behaviours of heterocycles.
Unit II: understand chemistry of important heterocyclic compounds.
Unit III: understand structure, chemical synthesis and biosynthesis of terpenoids and caretonoids.
Unit IV: understand structure, chemical synthesis and biosynthesis of alkaloids and steroids.
Unit V: understand chemistry of plant pigments and porphyrins.

Suggested Readings:

- The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
- Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
- Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical.
- Contemporary Heterocyclic Chemistry, G. R. Newkome and W. W. Paudler, Wiley-Inter Science.
- An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley.
- Natural Products: Chemistry and Biological Significance, J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthrope and J. B. Harborne, Longman, Essex.
- Organic Chemistry, Vol. 2, I. L. Finar, ELBS.
- Stereo selective Synthesis: A Practical Approach, M. Nogradi, VCH.
- Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
- Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas. Ed. Kurt Hostettmann, M. P. Gupta and A. Marston, Harwood Academic Publishers.
- Introduction to Flavonoids, B. A. Bohm, Harwood Academic Publishers.
- New Trends in Natural Product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.

M.Sc. Chemistry semester III CHE-SEC-EC-321B Heterocyclic Chemistry and Natural Products		
Credits : 3		45 Hrs
UNIT I	**Basic introduction:** Systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles, definition, characterization and properties of aromatic and non-aromatic heterocycles, conformational changes in non-aromatic heterocycles Basic Synthetic methods heterocycles like cyliclization and cyclocaddition, heterocyclic chemistry for 3,4, 5 and 6 member heterocyclic compounds.	9
UNIT II	Synthesis and reactions of some important heterocyclic compounds like benzopyrroles, benzofurans and benzothiophenes.Synthesis and reactions of pyrylium salts and pyrones, Six-membered heterocycles with two or more heteroatoms, like diazines, triazines, tetrazines and thiazines.	9
UNIT III	**Terpenoids and Carotenoids :** Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry	9
UNIT IV	**Alkaloids :** Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants, biosynthesis of alkaloids **Steroids:** Occurrence, nomenclature, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Testosterone, Progestrone. Biosynthesis of steroids, biosynthesis of steroids	9
UNIT V	**Plant Pigments :** Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Myrcetin, Quercetin-3-glucoside, Vitexin, Daidzein, Cyanidin-3, 5-diglucoside, Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway. **Porphyrins:** Structure and synthesis of haemoglobin and Chlorophyll.	9

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Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	Third	CHE-SEC-322	Laboratory course- Preparation, Extraction & Analysis	Mid Sem: 40 End Sem = 60	01

Course Objectives: To develop experimental skills on synthesis of organometallic compounds and extraction of the natural products.

Course Learning Outcomes: Upon successful learning, students will be able to learn
Unit I- Extraction of carboxylic acid and its salt from a natural product.
Unit II- Extraction of antibiotic from a medicine
Unit III- Extraction and analysis of chlorophyll
Unit IV- Synthesis of Schiff bases and their complexes
Unit V- Methods of preparation of resins

Suggested Readings:

- https://www.uvm.edu/~awurthma/Chem141Fall17/LabManual.pdf.
- Natural Product Chemistry Practical Manual for Science & Pharmacy Course, Anees A Siddiqui, Seemi Seediqui, CBS Publishers and distributers
- https://pendidikankimia.walisongo.ac.id/wp-content/uploads/2018/10/24-24.pdf

M.Sc. Chemistry semester III
CHE-DSM-322
Laboratory Course - Preparation, Extraction & Analysis

Credits : 1

UNIT	Experiments	30 Hrs
UNIT I	Extraction and recrystallization of carboxylic acid obtained from the natural product	6
UNIT II	Extraction of antibiotic	6
UNIT III	Extraction and analysis of chlorophyll	6
UNIT IV	Synthesis of Schiff bases and their complexes	6
UNIT V	Preparation of Urea-Formaldehyde resin	6