GAYATRI VIDYA PARISHAD
COLLEGE FOR DEGREE AND PG COURSES (AUTONOMOUS)
Affiliated to Andhra University || Accredited by NAAC and NBA
VISAKHAPATNAM

DEPARTMENT OF ORGANIC CHEMISTRY

SEMESTER-III, PAPER-I-ORGANIC REACTION MECHANISMS, PERICYCLIC REACTIONS AND PHOTOCHEMISTRY

(Effective from the admitted batch of 2024-2025)

Credits: 4	Paper/Course Code-3591	Theory: 4 Hours
Max Marks: 100	External: 60	Internal: 40

Course Objectives (COs):

CO 1: Analyze the radical reactions and mechanisms of substitution and their importance.
CO 2: Apply the mechanisms of pericyclic reactions.
CO 3: Analyze the advanced reactions and mechanisms of pericyclic reactions.
CO 4: Develop interest in the areas of reactions and mechanisms of organic photochemistry.
CO 5: Evaluate the concepts of advanced reactions and mechanisms in organic photochemistry.

Course Learning Outcomes (LOs):

Upon completion of the course the students should be able to:

LO 1: Familiarize the different types of nucleophilic and radical substitution reactions
LO 2: Analyze and solve to add nucleophiles, electrophiles and free radicals to carbon-hetero atom multiple bonds
LO 3: Interpret theoretical basis of pericyclic reactions and helps them to carry out these reactions.
LO 4: Apply the concept of pericyclic reaction in synthesis of organic compounds
LO 5: Basic concepts of organic photochemical reactions
LO 6: Photochemistry of carbonyl compounds, alkenes, dienes and aromatic compounds
LO 7: To know synthetically the processes relevant organic-chemical reactions and be able to discuss the mechanism of these reactions

UNIT-I: Radical Substitution Reactions [12 Hours]

Reactivity for aliphatic substrates, reactivity at Bridgehead, Reactivity in aromatic substrates, neighbouring group assistance in free radical reactions, reactivity in the attacking radical, effect of solvent on reactivity, halogenation at an alkyl carbon and allylic carbon, hydroxylation at aromatic carbon by means of Fenton's reagent, Hunsdiecker reaction, Kolbe reaction, Reed reaction and Sandmayer reaction.

UNIT-II: Pericyclic reactions-I: [12 Hours]

Molecular orbital symmetry - frontier orbitals of ethylene - 1,3-Butadiene, 1,3,5-Hexatriene, allyl system - classification of pericylic reactions - FMO approach - Woodward-Hoffman correlation diagram method and perturbation of molecular (PMO) approach for the explanation of pericyclic reactions under thermal and photochemical conditions. **Electrocyclic Reactions:** Conrotatory

and disrotatorymotions, (4n) and (4n+2) - allyl systems and secondary effects. **Cycloadditions:** Antarafacial and suprafacial additions, notation of cycloadditions, (4n) and (4n+2) systems with a greater emphasis on (2+2) and (4+2)- cycloadditions, and cheletropic reactions.

UNIT-III: Pericyclic reactions-II: **[12 Hours]**

FMO approach and perturbation of molecular (PMO) approach for the explanation of sigmatropic rearrangements under thermal and photochemical conditions - suprafacial and antarafacial shifts of H - sigmatropic shifts involving carbon moieties - retention and inversion of configurations, (3,3) and (5,5) sigmatropic rearrangements - detailed studies ofClaisen (Ireland-Claisen, Overman-Claisen, Johnson-Claisen) and Cope rearrangements - aza-Cope rearrangement and fluxional tautomerism

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UNIT-IV: Organic Photochemistry-I: **[12 Hours]**

Photochemical energy, Frank-Condon Principle - Jablonski diagram singlet and triplet states - dissipation of photochemical energy – photosensitization – quenching - quantum efficiency and quantum yield - experimental methods of photochemistry - photochemistry of carbonyl compounds n-π, π-π* transitions - Norrish type I and Norrish type II cleavages - Paterno-Buchi reaction.

UNIT-V: Organic Photochemistry-II: **[12 Hours]**

Photo reduction - hydrogen abstraction - rearrangement of α,β- unsaturated ketones and cyclohexadienones - photochemistry of p-benzoquinones - photochemistry of unsaturated systems – olefins, *cis-trans*-isomerization and dimerisation - hydrogen abstractions and addition acetylenes dimerization, dienes - photochemistry of 1,3-butadiene - photochemistry of cyclohexadienes. Di-pi methane rearrangement

Photochemistry of aromatic compounds – excited state of benzene and its 1,2-, 1,3-, 1-4- additions - photofries rearrangement - photofries reactions of anilides, photosubstitution reactions of benzene derivatives.

Text Books:

1. Advanced Organic Chemistry: Reactions Mechanisms and Structure by Jerry March, Mc.GrawHill andKogakush.
2. Molecular reactions and Photochemistry by Charles Dupey and O. Chapman, Prentice Hall.
3. Pericyclic reactions by S.N. Mukharji, Mcmilan.
4. Mechanisms and Theory in Organic Chemistry by T.H. Lowery and K.S. Richgardson.
5. The modern structural theory in Organic Chemistry by L.N.Ferguson, Pretice Hall.

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DEPARTMENT OF ORGANIC CHEMISTRY

SEMESTER-III, PAPER-II-ORGANIC SPECTROSCOPY
(Effective from the admitted batch of 2024-2025)

Credits: 4	**Paper/Course Code-3592**	**Theory: 4 Hours**
Max Marks: 100	**External: 60**	**Internal: 40**

Course Objectives (COs):

CO 1: Apply the knowledge of UV Spectroscopic technique.
CO 2: Apply the knowledge of IR Spectroscopic technique.
CO 3: Analyze and evaluate theChemical shifts, spin-spin splitting of any organic compounds using NMR spectroscopic technique.
CO 4: Analyze and evaluate the fragmentation process of any organic compounds using Mass spectroscopic technique.
CO 5: Analyze structure of anyorganic compound using UV, Infrared, NMR and Mass spectroscopic techniques.

Course Learning Outcomes (LOs):

Upon completion of the course the students should be able to:

LO 1: Interpret the values of dienes, dienophiles and aromatic compounds using UV-spectroscopy.
LO 2: Analyze the spectral data using IR spectroscopy.
LO 3: Interpret the structure of different organic molecules using NMR spectroscopy.
LO 4: Apply the concept of spin-spin splitting, coupling constants for different organic compounds for data interpretation.
LO 5: Identify the organic molecules using Mass spectroscopy
LO 6: Elucidate structure of Organic compounds by a combined application of the UV, IR, NMR and MASS spectral data.

UNIT-I: UV SPECTROSCOPY: **[12 Hours]**

UV spectra of aromatic and heterocyclic compounds, α-diketones, β-diketones, enediones and quinines. Applications of UV Spectroscopy-study of isomerism, determination of strength of hydrogen bonding.

UNIT-II: Infrared Spectroscopy: **[12 Hours]**

Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, carbonyl compounds, esters, amides, carboxylic acids, anhydrides, lactones, lactums, nitriles and conjugated carbonyl compounds. Effect of hydrogen bonding and solvent on vibrational frequencies.

UNIT-III: Nuclear Magnetic Resonance Spectroscopy (1H NMR):[12 Hours]

Nuclear spin, resonance, saturation, shielding of magnetic nuclei, chemical shifts and its measurements, factors affecting chemical shift, chemical and magnetic equivalence of spins, spin-spin coupling, integration, the coupling constant, types of spin-spin couplings, factors influencing coupling constants, first-order and non-first order spectra, spin system notations (ABX, AMX, ABC,A_2B_2 etc.).

A_2B_2 etc.). Simplification of non-first order spectra- use of higher magnetic fields, Deuterium exchange, Nuclear OverhauserEffect difference spectra,

UNIT-IV: Mass spectroscopy: **[12 Hours]**
McLafferty rearrangement, ortho effect.*retro*-Diels-Alder reaction, Fragmentation processes- fragmentation associated withvarious functionalgroups (alkanes, cycloalkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amides, amines, alkyl chlorides and alkyl bromides.

UNIT-V: Application of UV, IR, NMR and MASS **[12 Hours]**
Structural elucidation of Organic compounds by a combined application of the UV, IR, NMR and MASS spectral data.

Textbooks:

1. Spectroscopic identification of organic compounds by RM Silverstein, G C Basslerand T B Morrill
2. Organic Spectroscopy by William Kemp
3. Spectroscopic methods in Organic chemistry by DH Williams and I Fleming
4. Modern NMR techniques for chemistry research by Andrew B Derome
5. NMR in chemistry - A multinuclear introduction by William Kemp
6. Spectroscopic identification of organic compounds by P S Kalsi
7. Introduction to organic spectroscopy by Pavia
8. Carbon-13 NMR for organic chemists by GC Levy and O L Nelson
9. Nuclear Magnetic Resonance Basic principles by Atta-Ur-Rahman

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DEPARTMENT OF ORGANIC CHEMISTRY

SEMESTER-III, PAPER-III-ORGANIC SYNTHESIS
(Effective from the admitted batch of 2024-2025)

Credits: 4	Paper/Course Code-3593	Theory: 4 Hours
Max Marks: 100	External: 60	Internal: 40

Course Objectives (COs):

CO 1: Create different synthetic strategies using the formation of C-C in various reactions.
CO 2: Create different synthetic strategies using the formation of C=C in various reactions.
CO 3: Apply the knowledge of various oxidizing reagents in organic synthesis.
CO 4: Apply the knowledge of various reducing reagents in organic synthesis.
CO 5: Evaluate the areas of asymmetric synthesis in designing new organic molecules.

Course Learning Outcomes (LOs):

Upon completion of the course the students should be able to:

LO 1: Apply the concept of C-C bond formation using various reagents in organic synthesis.
LO 2: Apply the concept of C=C bond formation using various reagents in organic synthesis.
LO 3: Apply different oxidizing reagents in organic synthesis.
LO 4: Apply different reducing reagents in organic synthesis.
LO 5: Apply the knowledge of asymmetric synthesis in synthesizing pure enantiomers.

UNIT-I: Formation of Carbon-Carbon (C-C) single bonds: [12 Hours]

Alkylations *via* enolate - the enamine and related reactions - umploung (dipole inversion) – the aldol reaction – applications of organopalladium (Heck-Suzuki coupling and Stille-Sonogishira cross coupling - Negishi-Kumada coupling reactions) and organocopper reagents (Gillman reagent)- applications of sulphur ylides - synthetic applications of carbenes and carbenoids.

UNIT-II: Formation of carbon-carbon double bonds: [12 Hours]

Elimination reactions – pyrolytic syn eliminations – sulphoxide -sulphonate rearrangement - Wittig reaction-alkenes from arylsulphonylhydrazones (Shapiro reaction) - Eschenmoser fragmentation - olefin metathesis (Grubb's reaction), Peterson's olefination.

UNIT-III: Oxidation [12 Hours]

Oxidation: Metal based and non-metal based oxidations of (a) alcohols to carbonyls (Chromium, Manganese, aluminium, silver, ruthenium, DMSO, and TEMPO based reagents). (c) alkenes to epoxides (peroxides/per acids based), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation. (d) alkenes to diols (Manganese, Osmium based), Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification, (e) alkenes to carbonyls with bond cleavage (Manganese, Osmium, and ozonolysis) (f) alkenes

to alcohols/carbonyls without bond cleavage (selenium, chromium based allylic oxidation)

UNIT-IV: Reduction **[12 Hours]**

Reduction:(a) Catalytic hydrogenation (Heterogeneous: Palladium/Platinum/Rhodium/Nickel etc; Homogeneous: Wilkinson). Noyori asymmetric hydrogenation. (b) Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium, Zinc, Titanium and (Birch, Pinacol formation, McMurry, Acyloin formation, dehalgenation and deoxygenations) (c) Hydride transfer reagents-NaBH4 triacetoxyborohydride, L-selectride, K-selectride; LiAlH4, DIBAL-H, and Red-Al.

UNIT-V: A) Asymmetric Synthesis **[12 Hours]**

Topocity – Prochirality – Substrate selectivity – Diastereoselectivity and enantioselectivity –Substrate controlled methods – use of chiral substrates – examplesAuxiliary controlled methods – Use of chiral auxiliaries – Chiral enolates – alkylation of chiralimines-Reagent controlled methods – Use of chiral reagents – Asymmetric oxidation – Sharplessepoxidation – Asymmetric reduction – borate reagents.

Text Books:

1. Some Modem Methods of Organic Synthesis W. Carothers, Third Edition, Cambridge University Press, Cambridge, 1988.
2. Modern Synthetic Reactions, Herbert O. House, Second Edition, W.A. BenzamineInc. Menio Park, California, 1972.
3. Principle of Organic Synthesis- R.O.C. Norman and J. M. Coxon.(ELBS)
4. Advanced organic chemistry part A & B; Fourth edition; Francis A Cary and Richard J. Sundberg; Kluwer Academic/Plenum Publisher New York, 2000.
5. Organic chemistry Jonathan Clayden, Nick Geeves, Stuart Warren, 2nd Edition, 2012, Oxford University Press.
6. Stereochemistry of organic compounds — Principles & Applications by D Nasipuri.
7. Stereochemistry of Carbon compounds by Ernest L Eliel& Samuel H. wilen.
8. Stereochemistry: Conformation & Mechanism by P S Kalsi.
9. The third dimension in organic chemistry, by Alan Bassendale.
10. Stereo selectivity in organic synthesis by R S Ward.
11. Asymmetric synthesis by Nogradi.
12. Asymmetric organic reactions by J D Morrison and H S Moschcr.
13. Principles in Asymmetric synthesis by Robert E. Gawley& JEFFREY AUBE.

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DEPARTMENT OF ORGANIC CHEMISTRY

SEMESTER-III, PAPER-IV-CHEMISTRY OF NATURAL PRODUCTS
(Effective from the admitted batch of 2024-2025)

Credits: 4	Paper/Course Code-3594	Theory: 4 Hours
Max Marks: 100	External: 60	Internal: 40

Course Objectives (COs):

CO 1: Apply the knowledge of isolation, structural elucidation, stereochemistry, synthesis and biological properties of antibiotics, acetogenins and shikimates.

CO 2: Apply the knowledge of isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected terpenes.

CO 3: Apply the knowledge of isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected steroids.

CO 4: Apply the knowledge of isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected alkaloids

CO 5: Apply the knowledge of isolation, structural elucidation, stereochemistry, synthesis and biological properties of amino acids, proteins and nucleic acids.

Course Learning Outcomes (LOs):

Upon completion of the course the students should be able to:

LO 1: Explain the isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected antibiotics, Acetogenins and shikimates

LO 2: Apply the knowledge of isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected terpenes

LO 3: Develop the interest in isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected steroids.

LO 4: Develop the interest in isolation, structural elucidation, stereochemistry, synthesis and biological properties of selected alkaloids

LO 5: Explain the isolation, structural elucidation, stereochemistry, synthesis and biological properties of amino acids, proteins and nucleic acids

LO 6: apply the knowledge of structure, isolation and synthesis of various natural products to develop new derivatives.

UNIT-I: **[12 Hours]**

A) Antibiotics : Isolation, structure elucidation, stereochemistry, synthesis and biological properties of Penicillin G, Cephalosporin-C.

B) **Acetogenins and shikimates:** Prostaglandin 15 R PGA_2 - podophyllotoxin - etoposide

UNIT-II:

Terpenes **[12 Hours]**

Isolation, structure elucidation, stereochemistry, synthesis and biological properties of Terpenes: Forskolin, Taxol and Azadirachtin

UNIT-III: **[12 Hours]**

Steroids: Isolation, structure elucidation, stereochemistry, synthesis and biological properties of Steroids: Cholesterol - progesterone –testosterone

UNIT-IV:

Alkaloids **[12 Hours]**

Isolation, structure elucidation, stereochemistry, synthesis, and biological properties ofAlkaloids: Morphine, camptothecin.and Vincristine

UNIT-V: **[12 Hours]**

A) Peptides and Proteins: α-Aminoacids, their general properties and synthesis, Synthesis of peptides byMerrifield solid phase synthesis. Primary, secondary and tertiary structures of proteins

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

Text Books:

1. Organic Chemistry, Volume 2, Stereochemistry and chemistry of natural products, I.L. Finar, 5th Edition. ELBS.
2. Chemical A spects of Biosynthesis, John Mann, Oxford University Press, Oxford,1996
3. Chemistry of Natural Products. A Unified Approach, N.R. Krishnaswamy, University Press (India) Ltd., Orient Longman Limited, Hyderabad, 1999.
4. Chemistry of Natural Products, S. V. Bhat, Narosa Publishing House, 6th reprint 2010.

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SEMESTER-III, PAPER-V-PRACTICAL-I: MULTISTAGEORGANIC MOLECULE SYNTHESIS(Effective from the admitted batch of 2024-2025)

Credits: 4	Paper/Course Code-3595	Lab: 6 Hours
Max Marks: 100	External: 50	Internal: 50

PRACTICAL-I SYLLABUS

Multistage synthesis of six organic compounds involving three or more stages.

SEMESTER-III, PAPER-VI-PRACTICAL-II: CHROMATOGRAPHY &VIVA-VOCE(Effective from the admitted batch of 2024-2025)

Credits: 4	Paper/Course Code-3596	Lab: 6 Hours
Max Marks: 100	External: 50	Internal: 50

PRACTICAL-II SYLLABUS

1. Thin Layer Chromatography
2. Column Chromatography

Text Books:

1. Vogel's Practical Organic Chemistry, A.R. Tatchell, B.S. Furnis, A.J. Hannaford and P.W.G. Smith, 5th Edition, Pearson, New Delhi, 2017.

2. Vogel's Text book of Quantitative Inorganic Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th Edition, Pearson Education, New Delhi, 2008.

3. Chemistry of Natural Products: A Laboratory Handbook, N.R. Krishnaswamy, Universities Press, Hyderabad, 2013.

4. A Laboratory Manual of Organic Chemistry, R.K. Bansal, New Age International Publishers, New Delhi, 2008.

5. Practical Organic Chemistry, F.G. Mann & B.C. Saunders, Pearson, New Delhi, 2001.

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SEMESTER-III, PAPER-VII (Course Code-3597)-MOOCs
(Effective from the admitted batch of 2024-2025)

Credits: 4		**Theory: 4 Hours**
Max Marks: 100	**External: 50**	**Internal: 50**

Course Learning Outcomes:

Upon completion of the course the students should be able to:

LO 1:	The course gives foundation to the students for preparing NET, GATE, UPSC, SLET, SSC-CGL, various CETs and any competitive examination.
LO 2:	This course shall useful to students to pursue higher education in Ph.D. in national and global institutes.
LO 3:	The proposed course aims to provide essentials knowledge in chemistry and allied fields.
LO 4:	The course shall be helpful for PG students, research scholars, young scientists and faculty members for their career growth. PG and UG students who are in pursuit of excellence can learn more from this course.

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VALUE ADDED COURSE

SEMESTER-III, PAPER-VIII-INTELLECTUAL PROPERTY RIGHTS (IPR)

(Effective from the admitted batch of 2024-2025)

Credits: 2	Paper/Course Code-VA-3598	Theory: 2 Hours

Course Objectives (COs):

CO 1: Understand the fundamentals of intellectual property rights (IPR), basic concepts on IPR and importance of intellectual property rights.

CO 2: To explain the concepts of patent rights and copyrights.

CO 3: Students will explore the legal aspects of trademark infringement, available remedies, penalties, and the role of the trademarks.

Course Learning Outcomes (LOs):

Upon completion of the course the students should be able to:

LO 1: Students will gain knowledge of the patent registration procedure, and the necessary documentation, as well as the rights and duties of a patentee.

LO 2: Apply the knowledge of legal framework and regulations for applying patents for their innovations.

LO 3: Apply the knowledge of applying for a trademark to their products.

UNIT-1 **[10 hours]**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India.

UNIT-2 **[10 hours]**

Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non-Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents.

UNIT-3 **[10 hours]**

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) – Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.

Books:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.