

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS)

LATUR - 413512

DEPARTMENT OF CHEMISTRY



Syllabus

M.Sc. (Second Year) Organic Chemistry

(III & IV Semester)

With Effect From 2017-2018

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur
Syllabus
Faculty of Science
M.Sc. (Second Year) Organic Chemistry
Semester - III

Paper	Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
IX	P-ASM-343	Advanced Spectroscopic Methods	04	40	60	04
X	P-OTF-344	Organic Transformation	04	40	60	04
XI	P-CNP-345	Chemistry of Natural Products	04	40	60	04
XII	P-MDC-346	Medicinal Chemistry	04	40	60	04
Lab - IX	P-LAC-347	Lab Course-IX	04	20	30	02
Lab - X	P-LAC-348	Lab Course -X	04	20	30	02
Lab - XI	P-LAC-349	Lab Course XI	04	20	30	02
Total Credits						22

Theory Papers 100 Marks: (Internal 40*+External 60*)

*External S.E.E. 60 Marks Theory

* Internal 40 Marks (Two unit test -30 marks+ Attendance 10Marks)

Unit Test I MCQ patterns 60 MCQ questions

Unit Test II Activity Based 60 Marks

Unit test (I+ II) = 120 converted to 30 Marks

M.Sc. (Second Year) Organic Chemistry

Semester - IV

Paper	Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
XIII	P-ASM-439	Advanced Synthetic Methods	04	40	60	04
XIV	P-STE-440	Stereochemistry	04	40	60	04
XV	P-AHC-441	Advanced Heterocyclic Chemistry	04	40	60	04
XVI	P-AOC-442	Applied Organic Chemistry	04	40	60	04
Lab - XII	P-LAC-443	Lab Course-XII	04	20	30	02
Lab - XIII	P-LAC-444	Lab Course -XIII	04	20	30	02
Lab - XIV	P-LAC-445	Lab Course XIV	04	20	30	02
Lab- XV	P-LAC-446	Lab Course XV (Project)	04	40	60	04
Total Credits						26

Theory Papers 100 Marks: (Internal 40*+External 60*)

*External S.E.E. 60 Marks Theory

* Internal 40 Marks (Two unit test -30 marks+ Attendance 10Marks)

Unit Test I MCQ patterns 60 MCQ questions

Unit Test II Activity Based 60 Marks

Unit test (I+ II) = 120 converted to 30 Marks

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur
Syllabus
M.Sc. II (Organic Chemistry) (Semester - III)
(w.e.f. - 2017-18)
Paper IX
Core Course Title - Advanced Spectroscopic Methods
Course Code: P-ASM-343

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

1. To study principles of different advanced spectroscopic methods such as UV, IR, ¹H-NMR and Mass-spectrometry methods for the analysis of organic compounds.
2. To study applications of all spectroscopic methods for the elucidation of structures of an organic compounds.

Course Outcome:

1. After studying UV, IR, ¹H-NMR and Mass-spectrometry methods, students will be able to detect the nature as well as structure of organic compounds
2. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
3. By gaining knowledge of spectroscopic techniques students will be able to explore new areas of research in both chemistry and allied fields of science and technology

Unit-I UV and IR Spectroscopy :

15 Periods

A) Ultraviolet Spectroscopy

Introduction: spectroscopy, electromagnetic spectrum, Various Electronic transitions, Chromophores, Auxochromes, Bathochromic and Hypsochromic shifts, Hyperchromic and, Hypochromic shift, Effect of solvent on electronic transitions, Woodward-Fieser rules for dienes, polyenes, enones and aromatic compounds, Application of U.V. Spectroscopy.

B) IR Spectroscopy

Introduction, molecular vibration, fundamental modes of vibration, Hookes law, presentation of IR spectra, functional group region, finger print region, overtones; combination bands and Fermi resonance. Characteristic vibrational frequencies of alkanes; alkenes; alkynes; aromatic

compounds; alcohols; ethers; phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds [ketones; aldehydes; esters; amides; acids; anhydrides; lactones; lactams and conjugated carbonyl compounds] Effect of hydrogen bonding and solvent on vibrational frequencies. FT-IR of gaseous; solids and polymeric materials

Unit-II NMR Spectroscopy :

15 Periods

General introduction and definition; Principle of NMR spectroscopy.

PMR spectroscopy: spinning nuclei, magnetic moment and magnetic field, precessional motion, orientation and nuclear resonance, Equivalent and nonequivalent proton, Chemical shift; spin – spin interaction; shielding and deshielding mechanism of measurement; chemical shift values and correlation for protons bonded to carbons [aliphatic; olefinic; aldehydic and aromatic] and other nuclei [alcohols; phenols; enols; 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 coupling. shift reagent; solvent effect. Fourier transform technique; nuclear overhauser effect [NOE] Resonance of other nuclei – F; P.

Unit-III Mass Spectrometry :

15 Periods

Introduction- ion production- EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, 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.

Unit -IV C¹³NMR Spectroscopy :

15 Periods

A) Carbon-13 NMR Spectroscopy

General considerations; chemical shift [aliphatic; olefinic; alkyne; aromatic; heteroaromatic and carbonyl compounds]; problems associated with ¹³C, FT-NMR, proton decoupled off resonance.

B) Structural problems based on combined spectroscopic techniques.

References :

1. V.M. Parikh, Application spectroscopy of organic molecules. (Mehata)
2. D.W. Williams and Flemming, Spectroscopic methods of organic compound.
3. Silverstein and Basallar, Spectroscopic identification of organic compounds V.M.Parikh
4. Orption Spectroscopy of Organic Molecules (J. Wiley)
5. P.S. Kalsi Spectroscope of organic compounds (New age publisher)
6. J.R. Dyer. Application of absorption spectroscopy of organic compounds.
7. Jackman and Sterneil , Application of NMR spectroscopy
8. J.D. Roberts, Nuclear magnetic resonance (J. Wiley)
9. Jafee and Orchin, Theory and application of U.V,
10. K. Benjamin. Mass spectroscopy
11. Beynon J H et.al , The mass spectra of organic molecules.
12. Wehli F.W, Marchand A. P. Interpretation of carbon 13 NMR (J. Wiley)
13. W. Kemp, Organic spectroscopy ELBS
14. Willard Merritt and Dean. Instrumental methods of analysis CBS
15. Das and Jame , Mass Spectroscopy..
16. Organic spectroscopy Y. R . Sharma
17. Organic spectroscopy Pavia

Paper X
Core Course Title - Organic Transformation
Course Code: P- OTF-344

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

- 1.To understand the general mechanistic consideration, nature of migration, migratory aptitude of various rearrangements
- 2.To learn mechanism, stereochemistry and synthetic applications of selective organic reactions.
- 3.Understand about different oxidative processes.
- 4.To know about different reductive processes.

Course Outcome:

After successful completion of the course the students will :

- 1.Understand the general mechanistic consideration, nature of migration, migratory aptitude of Baeyer-Villiger, Benzillic acid, Favorskii, : Fries, Claisen rearrangements
2. Learn mechanism, stereochemistry and synthetic applications of Stork Enamine, Chichibabin, Diels-Alder etc.reactions
3. Understand about Oxidative cleavage of 1,2-diols, oxidation of allylic and benzylic C-H bonds
4. Know about different Catalytic hydrogenation, Wolff-Kishner and diimide reductions.

Unit - I Rearrangements :

15 Periods

General Mechanistic Consideration, Nature of migration, migratory aptitude

Memory Effects of following rearrangements:

- b) Rearrangement to Electron Deficient Carbon: Pinacol-pinacolone, Wagner-Meerwein, Benzillic acid, Wolf (Arndt-Eisterts Synthesis) Rupe and Demjanov rearrangements.
- c) Rearrangement to Electron Deficient Nitrogen: Hofman, Curtius, Schimdt, Lossen and Beckmann rearrangements
- d) Rearrangement to Electron Deficient Oxygen: Baeyer-Villiger rearrangement.
- e) Rearrangement to Electron Rich Carbon: Favorskii, Wittig, Neber and Steven's rearrangements.
- f) Aromatic Rearrangement: Fries, Claisen and Benzidine rearrangement

Unit – II Selective Organic Reactions :**15 Periods**

Mechanism, Stereochemistry and Synthetic Applications of following reactions

- a) Stork Enamine, Chichibabin, Diels-Alder, Bucherer, Ullmann, Chugaev, Biginelli, Prins, Hunsdiecker Reactions.
- b) Negishi, Suzuki, Buchwald-Hartwig Cross, Stille, Kumada, Heck coupling reactions.

Unit-III Oxidation Reaction :**15 Periods**

Introduction, different oxidative processes.

- a) Alcohols to carbonyl compounds: Chromium (VI) oxidants, Dimethyl sulfoxide and its modifications (Swern Oxidation), Manganese (IV) oxide, Silver carbonate, Oppenauer oxidation.
- b) Alkenes to epoxides: Peroxide induced epoxidation-epoxidation by H_2O_2 , hydroperoxides and peroxyacids.
- c) Alkenes to diols: oxidation by potassium permanganate, Osmium tetroxide, Prevost oxidation and Woodward modifications.
- d) Oxidative cleavage of 1,2-diols: Periodic acid, Lead Tetraacetate.
- e) Oxidation of allylic and benzylic C-H bonds: NBS, DDQ, Chloranil, SeO_2 .
- f) β -Oxidation: Definition, Activation of fatty acids, Four recurring steps, β -oxidation of fatty acids.

Unit- IV Reduction Reaction :**15 Periods**

Introduction, different reductive processes.

- a) Catalytic hydrogenation: Homogeneous and heterogeneous catalytic reductions. Dissolving metal reductions including Birch reduction.
- b) Non-metallic reductions: Wolff-Kishner and diimide reductions.
- c) Metal hydride reductions: Nucleophilic metal hydrides, $LiAlH_4$, and $NaBH_4$.
- d) Electrophilic metal hydrides: BH_3 and AlS_3 .

References:

1. Designing Organic Synthesis – S. Warren, Wiley
2. Some Modern Methods of Organic Synthesis, W. Carrathers, Cambridge Univ. Press
3. Modern synthetic reactions, H.O. House, W.A. Benjamin
4. Advanced Organic Reactions, Reactions, Mechanisms and Structure, J. March, Wiley
5. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional
6. Advanced Organic Chemistry Part - B, F.A. Carey and R.J. Sundberg, Plenum P.
7. Organic Reaction and Their mechanisms, P.S. Kalsi, New Age International Publishers.
8. Protective Groups in Organic Synthesis, T.W. Greene and P.G.M. Wuts. IInd Edition, John Wiley and Sons 1991.
9. Organic synthesis: The Disconnection Approach, Stuart Warren, John Wiley and sons.

Paper XI
Core Course Title - Chemistry of Natural Products
Course Code: P-CNP-345

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

- 1.To learn general methods of structure determination, isoprene rule and synthesis of Terpenoids & Carotenoids.
- 2.To understand nomenclature, occurrence, isolation, classification and synthesis of alkaloids
- 3.To know isolation, structure determination and synthesis of steroids.
- 4.To learn nomenclature and general methods of structure determination, and synthesis of Anthocyanins and Flavones.

Course Outcome:

After successful completion of the course the students will:

- 1.Learn general methods of structure determination, isoprene rule and synthesis of Citral, Geraniol, Menthol, Camphor, Phytol etc.
- 2.Understand nomenclature, occurrence, isolation, classification and synthesis of Ephedrine, atropine, Quinine and Morphine.
3. Know isolation, structure determination and synthesis of cholesterol, Bile acids, Androsterone.
- 4.Learn nomenclature and general methods of structure determination, and synthesis of cyanin, Hirsutidin chloride, Flavones and Flavonols, Qurcetin, and Isoflavones.

Unit - I Terpenoids & Carotenoids :

15 Periods

Classification, Nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule Structure determination, stereochemistry, and synthesis of the following representative molecules: Citral, Geraniol, Menthol, Camphor, Phytol, Abietic acid and β - Carotene.

Unit - II Alkaloids :

15 Periods

Definition, nomenclature and, occurrence, isolation, classification based on nitrogen heterocyclic ring. Structure, stereochemistry and synthesis of the following: Ephedrine, atropine, Quinine and Morphine, Taxol Reserpine

Unit - III Steroids :**15 Periods**

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone.

Unit - VI Anthocyanins and Flavones :**15 Periods**

Occurrence, nomenclature and general methods of structure determination. Synthesis of cyanidin chloride, cyanin, Hirsutidin chloride, Flavones (Kostanecki and Baker-Venkataraman approaches), Flavonols, Quercetin, and Isoflavones.

References :

1. The Organic chemistry of Drug Design and Drug Action, R.B.Silverman, Academicpress.
2. Natural Products: Chemistry and Biological Significance, J.Mann, R.S.Davidson,
3. J.B. Hobbs, D.V.Banthrope and J.B.Harborne, Longman, Essex.
4. Organic chemistry, Vol 2, I.L.Finar, ELBS.
5. Introduction to Flavonoids, B.A.Bohm, Harwood Academic publishers
6. New Trends in natural product chemistry, Atta-ur-Rahman and M.I.Choudhary, Harwood Academic publishers.

Paper XII
Course Title – Medicinal Chemistry
Course Code: P-MDC-346

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

1. Introduction of Medicinal chemistry and its terminology.
2. Drug designing, SAR and study of pro and soft drugs.
3. Synthesis, properties and uses of different drugs
4. Study of different antibiotics, their synthesis and mode of action.

Course Outcome:

After successful completion of the course the students will :

1. Understand about Medicinal chemistry and its terminology like pharmacodynamic agents, pharmacophore, pharmacodynamics etc.
2. Know about Drug designing methods, SAR and study of Pro and Soft drugs.
3. Understand about Synthesis, properties and uses of analgesic, antipyretic, antiaids , antimalarial etc.drugs.
4. Learn about different antibiotics, their synthesis and mode of action.

Unit - I Concepts of Medicinal Chemistry :

15 Periods

A) Concepts of Medicinal chemistry: Important terminology in medicinal chemistry: Drugs, Pharmacy, Pharmaceutics, Toxicology; Pharmacodynamic agents, Pharmacophore, Pharmacodynamics, metabolite and antimetabolites, chemotherapy. Mechanism of chemotherapeutic actions: 1) Biological defences 2) Chemical defences. a) Surface active agent, b) Metabolic antagonism. Assay of Drugs: Chemical assay, Biological assay, Immunological assay, LD-50 and ED-50

Unit-II

15 Periods

A] Drug Discovery.

- i) Introduction
- ii) Procedure followed in drug design.
- iii) Lead modification: Drug design and development
 - a) Identification of the active part: The pharmacophore, b) Functional group modification,
 - c) Structure-activity relationship, d) Structure modification to increase potency and the therapeutic index; 1) Homologation, 2) Chain branching, 3) Ring-chain transformation.,
 - 4) Bioisosterism, 5) Combinatorial Chemistry.

B] Concept of prodrugs and soft drugs.

- a) Prodrugs: i) Prodrugs designing, types of prodrugs, ii) Prodrug formation of compounds containing various chemical groups, Prodrugs and drug delivery system
- b) Soft drugs: i) Soft drug concept ii) Properties of soft drug.

Unit III: Study of the following drugs:

15 Periods

- a) Analgesic and antipyretic-Paracetamol, meperidine, morphine, aminopyrene
- b) Antiinflammatory- Ibuprofen, oxyphenbutazone, dichlorophenac, indomethacin, arachidonic acid
- c) Anesthetic- Lidocaine, thiopental, mechanism of action
- d) Antihistamine- Phenobarbiton, fenedazole, diphenyl hydramine, mechanism of action
- e) Antiaids drugs- Cause, antimetabolites and antiaid drugs
- f) Antimalaria-Trimethoprim, role of folic acid and its inhibition, mechanism of cell wall synthesis and inhibition

Unit IV: Antimicrobial drugs

15 Periods

A] Antitubercular drugs: Introduction.

- a) First-line agents (Primary tubercular drugs): Structure and activity of streptomycin and dihydro-streptomycin, Synthesis and SAR of 4-amino salicylic acid and isoniazid.
- b) Second line agents (Secondary antitubercular agents): Structure and activity of Rifampicin, Cycloserine, Viomycin, Ethionamide, Ethambutol,. (Synthesis of Cycloserine and Ethambutol expected)

B] Antileprotic drugs.

Chaulmoogra and hydrocarpus oil, Multidrug therapy, SAR of sulphones, Dapsone (DDS), Acedapsone, Diaminodipheyl thiourea, Rifampicin. (Synthesis of Acedapsone expected)

C] Antibiotics. drugs

- a) Cell wall synthesis inhibitors (β -Lactam antibiotics): Synthesis of Penicillin-V, Penicillin-G, amoxicillin, ampicilin from 6-APA, cephalixin, Structure and activity of benzyl penicillin, semi-synthetic penicillin, cephalosporin, Mode of action of penicillin and cephalosporin.
- b) Protein synthesis inhibitors: Structure activity of tetracycline and synthesis of chlortetracycline, Synthesis and SAR of chloramphenicol, Mode of action of chloroamphenicol.

References :

1. Medicinal chemistry-William O. Foye
2. T. B. of Organic medicinal and pharmaceutical chemistry-Wilson and Gisvold's (Ed.Robert F. Dorge)
3. An introduction to medicinal chemistry-Graham L. Patrick
4. Principles of medicinal chemistry (Vol. I and II)-S. S. Kadam, K. R. Mahadik and K. G. Bothara (Nirali prakashan)
5. Medicinal chemistry (Vol. I and II)-Burger
6. An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international)
7. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
8. Strategies for organic drug synthesis and design-D. Lednicer Wiley
9. Pharmacological basis of therapeutics-Goodman and Gilman's (McGraw Hill)

**M. Sc. III Semester
Laboratory Course-IX
Mixture Analysis
Course Code: P-LAC-347**

**Marks: 50
Credit: 02**

**Periods: 60
06 Periods Per Week**

Learning Objective:

1. To understand analysis of ternary mixtures of organic compound by separation with physical methods.
2. Learn about chromatographic Separation (TLC) techniques.

Course Outcome:

1. Students will able to separate ternary mixture and can analyse each component of the mixture.
2. They can know about chromatographic Separation (TLC) techniques.

Qualitative Analysis (At least 05 Organic Mixtures)

Semi-micro Qualitative Analysis of Ternary Mixtures (Two Solids and One Liquid) containing single/poly functional compounds by Chemical and Physical Method with Chromatographic Separation (TLC) for purity of all three components and its Expected Theoretical Spectral Data (IR, ^1H NMR & ^{13}C NMR).

M. Sc. Semester III
Laboratory Course-X
Synthesis of Organic Molecules
Course Code: P-LAC-348

Marks: 50
Credit: 02

Periods: 60
06 Periods Per Week

Learning Objective:

1. To synthesize different multicomponent reactions.
2. To learn the use of ultrasound in synthesis of organic compounds.

Course Outcome:

1. They obtained the skill in synthesis of different multicomponent reactions.
2. They can use of ultrasound in synthesis of organic compounds.

1. Multistage Synthesis (At least four) :

- a) Benzophenone → benzopinacol → benzopinacolone
- b) Benzoin → benzil → benzilic acid
- c) Benzaldehyde → chalcone → chalcone epoxide,
- d) Acetaldehyde → 4-bromoacetaldehyde → 4-bromo-2-chloroacetaldehyde → 2-chloro-4-bromoaniline.
- e) Cyclohexanone → cyclohexanone oxime → caprolactone
- f) Anthranilic acid → o-chlorobenzoic acid → N-phenyl Anthranilic acid → acridone

2. Use of ultrasound in organic synthesis. (One Each)

- a) Ultrasound-assisted one-pot synthesis of 2,4,5-triarylimidazole catalyzed by ceric (IV) ammonium nitrate in aqueous media from benzaldehyde, benzil/benzoin and ammonium acetate .
- b) Synthesis of Benzotriazoles by Ultrasound Irradiation from o-phenylenediamine.

Note:

1. Synthesis is carried out in molar quantities (Less than 5 gm).
2. Reaction with possible mechanism.
3. Calculate Theoretical and practical % yield.
4. Product confirmation by Physical constant and TLC.
5. Give expected spectral data (IR and NMR) of starting material, intermediate and final product.
6. All the prepared organic compounds should be stored as a sample and present at the time of University examination.

M. Sc. Semester III
Laboratory Course-XI
Physico-Organic Estimations
Course Code: P-LAC-349

Marks: 50
Credit: 02

Periods: 60
06 Periods Per Week

Learning Objective:

- 1.To understand the Physico organic estimations of drugs by titrimetric methods.
- 2.To learn the skill in estimation of drugs by instrumental methods.

Course Outcome:

- 1.They perform the Physico organic estimations of drugs by titrimetric methods.
- 2.They got the skill in estimation of drugs by instrumental methods.

A] Estimation of Drugs by Titrimetry: (At least three)

- a) Assay of Aspirin.
- b) Assay of Ibuprofen.
- c) Assay of Analgin.
- d) Determination of Chloride in Ringer Lactate solution for Injection.
- e) Determination of Calcium ions in Calcium Gluconate Injection.

B] Estimation of Drugs by Instrumental Methods: (At least Two)

- a) Assay of sulfanilamide by Potentiometry.
- b) Assay of Riboflavin by Colorimetry.
- c) Assay of ascorbic acid by Colorimetry.
- d) Assay of Diazepam by UV-Vis Spectrophotometer.

Note:

1. All required solutions must be prepared by the students.
2. In examination one experiment is on Instrumental and one should be on noninstrumental.

References :

1. Modern Experimental organic chemistry by Royston M. Robert, John C. Gilbert, Lyuu B. Rodewald & Alan S. Wingrove, Saunder International Edition
2. Advanced practical organic chemistry by N.K. Vishnoi
3. Experimental organic chemistry by L. M. Harwood & C. I. Moody, Blackwell Scientific Publications.
4. The systematic identification os organic compounds by R.L. Shriner & D.Y. Curtin
5. Semi-microqualitative organic analysis by N.D. Cheronis, J.B. Entrikin & E.M. Wodnett
6. Small scale organic preparation by P.J. Hill
7. Vogel's textbook of practical organic chemistry by ELBS, Longmann.

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M Sc II Year

Semester-IV

Paper - XIII

Core Course Title : Advanced Synthetic methods

Course Code: P-ASM-439

Marks:100

Credit : 04

Periods:60

04 Per Week

Learning Objective:

1. To learn how to design a new route for synthesis of various reactions.
2. To understand Retro- synthesis of aromatic heterocyclic 5 and 6 membered rings.
3. To familiarize with protection and deprotection of functional groups.
4. Know about the role of various reagents in synthetic methods.

Course Objective:

After successful completion of the course the students:

1. Can understand how to design a new route for synthesis of various reactions.
2. Can use Retro- synthetic methods in synthesis of aromatic 5 and 6 membered heterocyclic compounds.
3. Familiarize with protection and deprotection of functional groups.
4. Can know the role of LDA, DCC, DDQ, trimethyl silyl iodide etc. reagents in organic synthesis.

Unit - I Disconnection approach :

15 Periods

An introduction to Synthons and synthetic equivalents, disconnection approach, functional group interconversions. One group C-X and two group disconnections in 1,2,1,3 -,1,4-& 1,5-difunctional compounds , Retro- synthesis of Alkene ,acetylenes and aliphatic nitro Alcohols and carbonyl compounds, amines , the importance of the order of events in organic synthesis, chemoselectivity, regioselectivity. Diels Alder reaction, Michael addition and Robinson annulation. Retro- synthesis of aromatic Heterocycles and 5 and 6 membered carbocyclic and heterocyclic rings. Reversal of polarity (Umpolung).

Unit-II Protection and Deprotection of Groups :**15 Periods**

- a) Protecting Groups: Principle of protection of alcohol, amine, carbonyl and carboxyl (07)
- b) Application of the following in synthesis Merrifield resin, polymeric reagents. Solid phase synthesis of polypeptide & oligonucleotides, electro organic synthesis, enzyme catalyzed reaction in synthesis & resolution of racemic mixtures. (08)

Unit - III: Reagents & Reactions in Synthesis.**15 Periods**

Complex metal hydrides, lithium dialkyl cuprate, lithium diisopropylamide(LDA)
Dicyclohexylcarbodiimide(DCC), Trimethyl silyl iodide, tributyltin hydride, peracids, lead tetra acetate, PPA, Diazomethane , ozone phase transfer catalyst, Barton and Shapiro reaction
Hoffmann – Löffler- Freytag , Peterson synthesis. (08)

Selenium dioxide, crown ethers, DDQ, Dess-Martin periodinane, periodic acid & Iodoisobenzyl diacetate. (07)

Unit - IV Transition Metal Complexes in Organic Synthesis:**15 Periods**

- A) Fe, Mn, Co (07)
- B) Application of following metal in organic synthesis Pd, Hg, and Rh, Tl and Si (08)

References :

1. S.Warren: Designing of Organic Synthesis
2. J. Fuhrhop & G. Penzlin. : Organic synthesis (2nd ed.)
3. Carruthres: Some modern methods of organic synthesis.
4. H.O.House: Modern synthetic reaction.
5. Fieser & Fieser : Reagent in organic synthesis
6. R.O.C.Norman: Principle of organic synthesis
7. Carey & Sundharg: Advanced organic Chemistry
8. P.E. Reiland: Organic synthesis
9. Bartan and Ollis : Comprehensive organic Chemistry
10. R. Adams: Organic reactions
11. Stone & West: Advances in Organometallic Chemistry

- 12.C.W. Bird: Transition metal intermediate in organic synthesis
- 13.Swan & black: Organometallic in organic synthesis.
- 14.A. Mitra: Synthesis of prostaglandins
- 15.John Apsimon: Total synthesis of natural products
16. M. K. Mathur, C. K. Narang & R.E. Williams: Polymers as aid in organic synthesis
- 17.P. Hodge & D.C. Sherrington: Polymer supported reaction in organic synthesis.
- 18.C.J.Gray: Enzyme Catalysed reactions
- 19.T.W. Green & P.G.M. Wats : Protecting groups in organic Chemistry
- 20.T.Shona: Electroorganic Chemistry
- 21.Weber & Gokel : phase transfer catalyst in organic synthesis.

Chemistry Paper – XIV
Core Course Title – Stereochemistry
Course Code: P-STE-440

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

- 1.To understand the basic concept of stereochemistry, stereo chemical principles.
- 2.To familiarize with newer methods of stereoselective synthesis.
- 3.To know about conformational analysis and stereochemistry of ring systems.
- 4.To learn about stereochemistry of fused and bridged rings.

Course Outcome:

After successful completion of the course the students will :

- 1.Understand the basic concept of stereochemistry like chirality, stereo chemical principles like enantiomeric and diastereomeric relationship, D & L, R & S and E & Z nomenclature.
2. Familiarize with newer methods of stereoselective synthesis like Regioselective and Chemoselective reactions, Stereospecific and stereoselective reactions etc.
3. Know about conformational analysis of cyclohexane, mono substituted and disubstituted cyclohexanes and stereochemistry of ring systems.
4. Learn about stereochemistry of fused and bridged rings, O.R.D. and C.D

Unit - I Basic concepts in stereochemistry :

15 Periods

Introduction: definition- Stereoisomerism

- 1) Molecular symmetry and concept of Chirality. Simple or proper axis of symmetry, plane of symmetry, centre of symmetry, improper or alternating or rotation reflection axis of symmetry
- 2) Stereo chemical principles: enantiomeric relationship, diastereomeric relationship. D & L, R & S and E & Z nomenclature. Threose and Erythrose nomenclature. Racemic Modification and Resolution. Prochiral relationship.

Unit - II Newer methods of stereoselective synthesis :**15 Periods**

Regioselective and Chemoselective reactions, Stereospecific and stereoselective reactions, Enantioselective synthesis (chiral approach) reactions with hydride donors, Bromination, hydroboration, catalytic hydrogenation via chiral hydrazones and oxazolines. Sharpless epoxidation. Diels Alder selective synthesis, use of calculations of optical purity and enantiomeric excess, Introduction of optical activity in absence of chiral carbon (biphenyls, spiranes and allenes) assignment of configuration, Configuration of distereomers based on physical and chemical methods. Dynamic Stereochemistry

Unit-III Conformational analysis :**15 Periods**

- a) Conformational analysis of cyclohexane, mono substituted and disubstituted cyclohexane
- b) Some aspects of the stereochemistry of ring systems: Stereoisomerism and determination of configuration Stability of rings and ease of rings formation)
- c) The shapes of the rings other than six membered: Shapes of five, and seven membered rings. Conformational effects in medium sized rings, Concept of I strain.

Unit - IV Stereochemistry of Fused and Bridged Rings :**15 Periods**

- a) Fused and bridged rings: Fused bicyclic ring systems : Cis and trans decalins and perhydrophenanthrene. Bridged rings, Nomenclature stereochemical restrictions, and The Bredt's rule, Reactivities.
- b) O.R.D. and C.D.: Types of curves, the axial haloketone rule. The Octant rule. Determination of conformation and configuration.

References :

1. E.L. Eliel : Stereochemistry of carbon compounds
2. D. Nasipuri : Stereochemistry of organic compounds
3. P.S. Kalsi: Stereochemistry: conformation and Mechanism.
4. Eliel, Allinger, Angyal and Morrison : Conformational analysis
5. Hallas: Organic stereochemistry
6. Mislow and Benjamin: Introduction to stereochemistry.
7. H. Kagan : Organic stereochemistry.
8. Carl Djerassi ; Optical rotatory dispersion.
9. P. Crabbe : Optical rotatory dispersion and C.D.

Chemistry Paper - XV
Core Course Title - Advanced Heterocyclic Chemistry
Course Code: P-AHC-441

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

- 1.To outline the role of heterocycles,their spectral characteristics , reactivity.
2. To understand the synthesis and aromatic character of heterocycles.
3. To know the synthesis of Indole Quinoline, Isoquinoline, Benzothiapene etc.

Course Outcome:

- 1.Student can understand the role of heterocycles,their spectral characteristics , reactivity.
- 2.They can know how to synthesize Azirines, Oxaranes, Thiiranes, Diazirenes etc.
- 3.They can understand the synthesis and reactivity of Indole Quinoline, Isoquinoline, Benzothiapene etc.

Unit - I Introduction to Heterocycles and Small (3 and 4) membered Heterocycles :

15 Periods

Nomenclature (Hantzsch Widman System), spectral characteristics, reactivity and aromaticity of monocyclic, fused and bridged heterocycles, Different types of strains, interactions and conformational aspects on nonaromatic heterocycles. Synthesis, reactivity and importance of the following ring systems, Azirines, Oxaranes, Thiiranes, Diazirenes, Diaziridines, Azetidines.

Unit II : Five and six-membered heterocycles with two hetero atoms : 15 Periods

Synthesis, reactivity, aromatic character and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidine, Pyrazine, Oxazine, and Thiazine.

Unit III: Heterocycles with more than two hetero atoms: 15 Periods

Synthesis, reactivity, aromatic character and importance of the following heterocycles: Triazoles, Oxadiazoles, Thiadiazoles, Triazines.

Unit-IV:Larger ring and Benzofused heterocycles:**15 Periods**

Synthesis and reactivity of Indole, Quinoline, Isoquinoline, Benzothiapene, Benzofuran, Azepines, Oxepines and Thiepines, Synthesis and rearrangement of Diazepines, Synthesis of Benzoazepines, Benzodiazepines, Benzooxepines, Benzothiepines, Azocines, and Azonines.

References :

1. Heterocyclic Chemistry, T. L. Gilchrist.
2. An Introduction to the Chemistry of Heterocyclic compounds, R. M. Acheson.
3. Heterocyclic chemistry, J. A. Joule & K. Mills.
4. Principals of Modern Heterocyclic Chemistry, A. Paquette.
5. Heterocyclic Chemistry, J. A. Joule & Smith.
6. Handbook of Heterocyclic Chemistry, A. R. Katritzky.
7. Heterocyclic Chemistry R.K. Bansal.

Chemistry Paper – XVI
Semester IV
Course Title: Applied Organic chemistry
Course Code:P-AOC-442

Marks:100
Credit : 04

Periods:60
04 Per Week

Learning Objective:

1. Introduction of supramolecular chemistry
2. To know in detail about structural features of carbohydrate and vitamins
3. To familiarize with role of green reagents in organic synthesis.
4. To learn about green synthetic routes of reactions.

Course Outcome:

After successful completion of the course the students will:

1. Learn about supramolecular chemistry and structures of supramolecules like nucleic acid, crown ether, cyclophanes, calixarenes
2. To know in detail about structural features of carbohydrate and vitamins
3. To familiarize with role of green reagents in organic synthesis.
4. To learn about green synthetic routes of reactions.

Unit - I Supramolecular Chemistry :

15 Periods

Principles of molecular associations and organizations as exemplified in biological macromolecules like nucleic acids, proteins and enzymes. **(3L)**

Synthetic molecular receptors: receptors with molecular cleft, molecular tweezers, receptors with multiple hydrogen sites. **(3L)**

Structures and properties of crown ethers, cyclophanes, calixarenes, Synthesis of crown ethers, cryptands and calixarenes. **(6L)**

Unit - II Carbohydrates and Vitamins :**15 Periods****A) Carbohydrates**

Introduction to naturally occurring sugars: Deoxysugars, aminosugars, branched sugars, structure elucidation of lactose, D-glucosamine and mesoinositol (synthesis not expected), Structural features and applications of inositol, starch, cellulose, chitin and heparin.

B) Vitamins

Classification, sources, biological functions, deficiency diseases and synthesis of A, B1, B2, B6, and E.

Unit - III Green Chemistry-I :**15 Periods**

Introduction, basic principles of green chemistry, designing a green synthesis: Green starting materials, green reagents, green solvents and reaction conditions, green catalysts.

Use of the following in green synthesis with suitable examples:

- a) Green reagents: dimethylcarbonate.
- b) Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts [benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride.
- c) Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide

Unit - IV: Green Chemistry-II**15 Periods**

- a) Solid state reactions: solid phase synthesis, solid supported synthesis.
- b) Microwave assisted synthesis: reactions in water, reactions in organic solvents, solvent free reactions
- c) Ultrasound assisted reactions.
- d) Multicomponent reaction

References :

1. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
2. Supramolecular Chemistry; Concepts and Perspectives, J. M. Lehn, VCH.
3. Crown ethers and analogous compounds, M. Hiraoka, Elsevier, 1992.
4. Large ring compounds, J.A.Semlyen, Wiley-VCH, 1997
5. Enzyme catalysis in organic synthesis, 3rd edition. Edited by Karlheinz Drauz, Harold Groger, and Oliver May, Wiley-VCH Verlag GmbH & Co KgaA, 2012.
6. Biochemistry, Dr U Satyanarayan and Dr U Chakrapani, Books and Allied (P) Ltd.
7. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
8. The Organic Chemistry of Enzyme-Catalysed Reactions, Academic Press, By Richard B.Silverman
9. Enzymes: Practical Introduction to structure, mechanism and data analysis, By Robert A.Copeland, Wiley-VCH, Inc.
10. The Organic Chemistry of Biological Pathways By John McMurry, Tadhg Begley by Robert and company publishers
11. Biochemistry By Lehninger
12. Bioorganic Chemistry- A practical approach to Enzyme action, H. Dugas and C. Penny. Springer Verlag, 1931
13. Biochemistry: The chemical reactions in living cells, By E. Metzler. Academic Press.
14. Concepts in biotechnology by D. Balasubramanian & others
15. Principles of biochemistry by Horton & others.
16. Bioorganic chemistry - A chemical approach to enzyme action by Herman Dugas and Christopher Penney.
17. Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B.G. Torssell, Apotekarsocieteten – Swedish pharmaceutical press.
18. Natural products Chemistry and applications, Sujata V Bhat, B.A. Nagasampagi and S.Meenakshi, Narosa Publishing House
19. Natural Products Volume- 2, By O. P. Agarwal
20. Chemistry of Natural Products, F. F. Bentley and F. R. Dollish, 1974

21. Natural Product Chemistry Vol.1 and 2, K. Nakanishi J. Goto. S.Ito Majori and S. Nozoo, Academic Press, 1974.
22. Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co.
23. Green Chemistry: An Introductory Text, 2nd Edition, Published by Royal Society of Chemistry, Authored by Mike Lancater
24. Organic synthesis in water. By Paul A. Grieco, Blackie.
25. Green chemistry, Theory and Practical, Paul T. Anastas and John C. Warner.
26. New trends in green chemistry By V.K. Ahulwalia and M. Kidwai, 2nd edition, Anamaya Publishers, New Delhi
27. An introduction to green chemistry, V. Kumar, Vishal Publishing Co
28. Organic synthesis: Special techniques. V.K. Ahulwalia and Renu Aggarwal.

**M. Sc. IV Semester
Laboratory Course-XII
Mixture Analysis
Course Code: P-LAC-443**

**Marks: 50
Credit: 02**

**Periods: 60
06 Periods Per Week**

Learning Objective:

1. To perform the semi-micro qualitative analysis of ternary mixtures containing single/poly functional compounds by Chemical and Physical Method.
2. To check the purity of compounds by performing TLC method.

Course Objective:

1. Students can perform semi-micro qualitative analysis of ternary mixtures.
2. They can check purity of compounds by TLC.

Qualitative Analysis (At least 05 Organic Mixtures):

Semi-micro Qualitative Analysis of Ternary Mixtures (One Solid and Two Liquids) containing single/poly functional compounds by Chemical and Physical Method with Chromatographic Separation (TLC) for purity of all three components and its Expected Theoretical Spectral Data (IR, ^1H NMR & ^{13}C NMR).

M. Sc. Semester IV
Laboratory Course- XIII
Physico-Organic Estimations
Course Code: P-LAC-444

Marks: 50
Credit: 02

Periods: 60
06 Periods Per Week

Learning Objective:

- 1.To develop the skill in the isolation and purification of natural products like beta carotene, piperine lycopene.
- 2.To estimate the amount of drug sample by instrumental methods.

Course Outcome:

- 1.Students can develop the skill in the isolation and purification of natural products like beta carotene, piperine lycopene.
- 2.They can perform assay of drugs.

A] Isolation of natural products. (At least three)

- a) Isolation of caffeine from tea leaves.
- b) Isolation of piperine from black pepper
- c) Isolation of β -carotene from carrots
- d) Isolation of lycopene from tomatoes
- e) Isolation of limonene from lemon peel
- f) Isolation of eugenol from cloves

B] Estimation of Drugs by Instrumental Methods: (At least Two)

- a) Assay of Riboflavin by UV-Vis Spectrophotometer.
- b) Estimation of carbohydrates, amino acids, proteins by UV-Vis spectrophotometer.
- c) Determination of Hammett constants and determine its substitution effect.
- i) Benzoic acid, ii) P-Nitro Benzoic acid, iii) P-Methoxy Benzoic acid, iv) PMethyl benzoic acid, v) P-Chloro benzoic acid.

(Out of two compounds one compound must be benzoic acid and another should be substituted benzoic acid is given to the students)

Note:

1. All required solutions must be prepared by the students.
2. In examination one experiment is on Instrumental and one should be on noninstrumental.

References :

1. Modern Experimental organic chemistry by Royston M.Robert, John C.Gilbert, Lyuu B.Rodewald & alan S.Wingrove, Saunder International Edition
2. Advanced practical organic chemistry by N.K.Vishnoi
3. Experimental organic chemistry by L. M. Harwood & C. I. Moody, Blackwell Scientific Publications.
4. The systematic identification of organic compounds by R.L.Shriner & D.Y.Curtin
5. Semi-microqualitative organic analysis by N.D.Cheronis, J.B.Entrikin & E.M.Wodnett
6. Small scale organic preparation by P.J.Hill
7. Vogel's textbook of practical organic chemistry by ELBS, Longmann.

M. Sc. Semester IV
Laboratory Course- XIV
Synthesis of Organic Molecules
Course Code: P-LAC-445

Marks: 50
Credit: 02

Periods: 60
06 Periods Per Week

Learning Objective:

1. To develop the skill in the synthesis of different antibacterial, anticancer, anti-convulsant drugs.
2. To use ultrasound techniques in the synthesis of heterocyclic compounds.

Course Outcome:

1. Students can synthesize different drugs like antibacterial, anticancer, anti-convulsant etc.
2. They can use ultrasound techniques in the synthesis of heterocyclic compounds.

1. Synthesis of Drug Molecules (At least Four)

- a) Synthesis of anaesthetic drug Benzocaine.
- b) Synthesis of anticancer drug 6-methyl uracil.
- c) Synthesis of antibacterial drug sulfanilamide.
- d) Synthesis of anti-epileptic drug antipyrine.
- e) Synthesis of anti-convulsant drug Phenytoin.

2. Use of ultrasound in organic synthesis. (One Each)

- a) Ultrasound assisted Hantzsch dihydropyridine synthesis from aldehydes, ethyl acetoacetate and urea.
- b) Synthesis of coumarin by Knoevenagel synthesis using salicylaldehyde, ethyl acetate in presence of base by ultrasound assistance.
- c) Ultrasound promoted synthesis of dihydropyrimidones from Biginelli Reaction by acid-catalyzed, three component reaction between an aldehyde, β -ketoester and urea.

Note:

1. Synthesis is carried out in molar quantities (Less than 5 gm).
2. Reaction with possible mechanism.
3. Calculate Theoretical and practical % yield.
4. Product confirmation by Physical constant and TLC.
5. Give expected spectral data (IR and NMR) of starting material, intermediate and final product.
6. All the prepared organic compounds should be stored as a sample and present at the time of University examination.

M. Sc. Semester IV
Laboratory Course-XV
Course Code:P-LAC-446
Project

Marks: 50
Credit: 04

Periods: 60
06 Periods Per Week

Learning Objective:

- 1.To learn about Literature Survey,synthesis of different natural products.
- 2.To learn about different standardization of reaction Conditions and their synthetic methods.

Course Outcome:

- 1.Students can learn about literature survey,synthesis of different natural products.
- 2.They can understand about different standardization of reaction Conditions and their synthetic methods.

Literature Survey, Studies of Reactions, Synthesis, Mechanism, Isolation of Natural Products, Standardization of Reaction Conditions, New Synthetic Methods etc.

Note:

1. External and Internal Examiners will examine this project jointly at the time of practical examination.
2. The students will have to give at least one seminar in each semester in their subject of specialization is compulsory.
3. Project work must be carried out only in specialized branch.
4. All synthesized organic compounds should be submitted at the time of University Examination.
5. The project work carried out during the year should be presented in power point presentation in presence of University Examiners.
