M.Sc.II (ORGANIC CHEMISTRY) REVISED SYLLABUS-2009

SEMESTER - III

CH -350:	**ORGANIC REACTION MECHANISM**
CH -351:	**SPECTROSCOPIC METHODS IN STRUCTURE DETERMINATION**
CH -352:	**ORGANIC STEREOCHEMISTRY**
CH – 353:	**FREE RADICALS, PHOTOCHEMISTRY PERICYCLIC REACTIONS AND THEIR APPLICATIONS**

SEMESTER – IV

CH - 450:	**CHEMSITRY OF NATURAL PRODUCTS**
CH- 451:	**SYNTHETIC METHODS IN ORGANIC CHEMISTRY**
CH- 452:	**HETEROCYCLIC CHEMISTRY, CHIRON APPROACH & MEDICINAL CHEMISTRY**

PRACTICAL COURSES

CH - 347:	**TERNARY MIXTURE SEPARATION**
CH- 447:	**SINGLE STAGE AND TWO STAGE PREPARATIONS**
CH - 448:	**PROJECT AND PRACTICALS:**

M.Sc.II (ORGANIC CHEMISTRY) REVISED SYLLABUS-2009

SEMESTER - III

CH - 350

ORGANIC REACTION MECHANISM (60L

1.	Carbanions - Formation, stability and mechanisms of important reactions. Enamines-formation and applications Ref. 1, 2, 3 and 7	(14)
2.	Reactions of carbenes and nitrenes. Ref. 7 and relevant pages from 8	(04)
3.	Neighbouring group participation Ref. 1	(10)
4.	Ester hydrolysis (acid and base catalysed) Ref. 1	(08)
5.	Kinetic and non-kinetic methods used for determination of reaction mechanism. Ref. 1	(06)
6.	Hammett equation and its applications. Linear free energy relationship Ref. 1, 3, 4, 5, 6	(08)
7.	Mechanisms in biological chemistry Ref. 7 pp 1381-1412	(10)

Books:

1. Mechanism and structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston)
2. Advanced organic chemistry by J. March, 6th Ed.
3. Advanced organic chemistry part-A. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)
4. Physical Organic chemistry – J. Hine
5. A guidebook to mechanism in organic chemistry – Peter Sykes 6th Ed. Orient Longman
6. The Hammett equation – C. D. Johnson, Cambridge University Press (1973)
7. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers. Oxford University Press (2001)
8. Michael P. Doyle and David C. Forebes, **Chem. Rev**. 98, 911-935 (1998)

CH- 351

SPECTROSCOPIC METHODS IN STRUCTURE DETERMINATION (60L)

1. Recapitulation of UV, IR and ^{1}H NMR. (02)
2. ^{1}H NMR (Advanced ideas) FT – techniques, Spin Coupling, Ramsay mechanism of spin coupling, different spin systems (AB, AM, AX, AMX systems, calculation of line intensities and chemical shifts), factors affecting coupling constants, rate processes. Different types of coupling. Methods used for simplification of PMR spectra. NOE, spin decoupling. Two dimensional (2D) NMR Techniques (DEPT with 3 different angles, COSY, HETCOR). Medical application of PMR (23)
3. ^{13}C NMR elementary ideas, instrumental problems, chemical shift features of hydrocarbons, effect of substituents on chemical shifts, different type of carbons (Alkene, alkyne, allene and carbonyl) (12)
4. Mass Spectrometry – Theory, instrumentation, various methods of ionisation (field ionisation, SIMS, FAB, MALDI, Californium plasma), different detectors (magnetic analyzer, ion cyclotron analyzer, Quadrupoule mass filter) time of flight (TOF). Rules of fragmentation of different functional groups, factors controlling fragmentation. (15)
5. Problems based on joint application of UV, IR, PMR, CMR, and Mass. (08) (Including reaction sequences) Ref.9

Books:

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry - D. H. Williams and I. Flemming Mc Graw Hill
4. Absorption spectroscopy of organic molecules – V. M. Parikh
5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986).
6. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
7. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998)

8. Organic structural Spectroscopy- Joseph B.Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).

9. Organic structures from spectra –Field L.D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.

CH – 352

ORGANIC STEREOCHEMISTRY (60L)

1. Stereochemistry of six membered rings and reactions thereof. (08)

   Ref. 1, 6, 7

2. Stereochemistry of rings other than six membered (05)

   Ref. 1, 6, 7

3. Fused Bridged and caged rings (10)

   Ref. 1, 2, 6, 7

4. Resolution of racemic modification (07)

   Ref. 1, 6, 7

5. Recapitulation of prochirality, homotopic and heterotopic ligands, stereoselectivity in cyclic compounds, enantioselectivity, diastereoselectivity, stereoselective aldol reactions. Cram's rule, Felkin Anh rule, Cram's chelate model. Asymmetric synthesis use of chiral auxiliaries, chiral reagents and catalysts, asymmetric hydrogenation, asymmetric epoxidation and asymmetric dihydroxylation. (20)

   Ref. 3 chapters 33, 34, 35

6. Stereochemistry of Morphine, Quinine and Lactone Fusion in Enhydrin including principles of ORD ,CD (10)

   Ref. 4, 5, 6

Books:

1. Stereochemistry of carbon compounds - E. L. Eliel
2. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen
3. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press.)
4. Chemistry of Natural Products – N. R. Krishnaswamy (University Press)
5. Organic Chemistry vol. II - I. L. Finar, 5^{th} edition (Longman)
6. Stereochemistry of organic compounds –Nasipuri
7. Stereochemistry of organic compounds-Kalsi
8. Organic stereochemistry - JagdambaSingh

CH – 353

FREE RADICALS, PHOTOCHEMISTRY

PERICYCLIC REACTIONS AND THEIR APPLICATIONS (60L)

1. Formation, stability and detection of long and short-lived radicals. Homolysis and free radical displacement, addition and rearrangements, Radical cyclisation in synthesis. (15)

   Ref. 1, 2, 3

2. Photochemistry – general principles, photochemistry of carbonyl compounds, aromatic compounds, alkenes and dienes. (15)

   Ref. 2, 4

3. Pericyclic reactions – Analysis (correlation diagrams, FMO approach, ATS concept) and examples of electrocyclic, cycloaddition, sigmatropic reactions and ene reactions. (20)

   Ref. 2, 5, 6, 7

4. Application of photochemical reactions in synthesis– Isocomene, Cedrene, Ladderane and Vitamin D_3, (05)

   Ref. 8, 9, 10, 11, 12,13

5. Application of Pericyclic reactions in synthesis – Endiandric acids A – D. (05)

   Ref. 8

Books/References:

1. Mechanism and structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston)
2. Advanced Organic Chemistry, Part A – F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007).
3. Radicals in Organic Synthesis B. Giese, Pergamon press (1986)
4. a) Organic photochemistry: A visual approach-Jan Kopecky, VCH publishers (1992).

   b) Excited states in Organic Chemistry- J.A. Barltrop and J.D.Coyle, John Wiley & sons
5. Conservation of orbital symmetry – R. B. Woodward and R. Hoffmann; Verlag chemie, weinheim (1970).

6. Orbital Symmetry : A problem solving approach- R. E. Lehr and A. P. Marchand; Academic (1972).
7. Organic reactions and orbital symmetry, 2nd Ed. T. L. Gilchrist and R. C. Storr; Cambridge University Press.
8. Classics in total synthesis- K. C. Nicolaou and E. J. Sorensen; VHC (1996)
9. P. A. Wender and J. J. Howbert **J. Am. Chem. Soc**. **103**, 688-690 (1981)
10. Henning Hopf et al **Eur. J. Org. Chem.**, 567-581, (2005)
and references cited therein.
11. G.Mehta, M.B.Viswanath et al **Angew Chem**, **104**, 1557-1558 (1992)
and references cited therein
12. D.H.R. Barton et al **J. Am. Chem. Soc**. **95**(8), 2748-2749 (1973).
13. Henning Hopf, **Angew.Chem.Int.Ed**. 42, 2822-2825 (2003).

SEMESTER – IV

CH - 450

CHEMSITRY OF NATURAL PRODUCTS (60L)

1. Structure , stereochemistry and biogenesis of Hardwickiic acid, Camptothecin and Podophyllotoxin (10)

   Ref. 1 to 4 and 11

2. Synthesis of (20)

   i) Reserpine (Woodward synthesis) Ref. 5,6

   ii) Taxol Ref. 6

   iii) Estrone and Mifepristone Ref. 6,7

   iv) Strychnine (Overman's synthesis) Ref. 6

   v) Fredericamycin A Ref. 5

3. Biogenesis – The building blocks and construction mechanism of (30)

   1. Terpenoids – Mono, Sesqui, Di and Triterpenoids and cholesterol
   2. Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan.
   3. The shikimate pathway – cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbens, isoflavanoids and terpenoid quinones.

      Ref. 8, 9, 10

Books/References:

1. **J. Am Chem. Soc**. **88,** 3888 (1966).
2. M. C. Wani and M. E. Wall **J. Org. Chem. 34**, 1364 (1969).
3. (i) **Tetrahedron Letters**, 3751 (1964).,

   (ii) **Tetrahedron Letters**, 2861 and 2865 (1968).
4. Chemistry of Natural products- Kalsi
5. Principles of organic synthesis by R. O. C. Norman and J.M.Coxon; Chapman and Hall
6. Classics in organic synthesis – K. C. Nicolaou & E. J. Sorensen
7. **J.Indian Inst.Sci**. 81,287 (2001).

8. Medical Natural Products - A Biosynthetic approach by Paul M. Dewick 2nd edition (Wiley)
9. Secondary metabolism - J. Mann, 2nd edition.
10. Chemical aspects of Biosynthesis – J. Mann (1994).
11. i) **J.C.S. Perkin Transactions II**, 288-292, (1973).
    ii) **J.Am.Chem.Soc**. Vol.77.432-437, (1955).

CH – 451

SYNTHETIC METHODS IN ORGANIC CHEMISTRY (60L)

1. Transition metal complexes in organic synthesis ; only Pd, Ni, Co, Pt, Fe, Rh, Ru; Grubb's catalyst, Ziegler Natta catalyst. (15)
2. Use of Boron, Silicon and Tin in organic synthesis (12)
   Ref.2, chapter 47
3. Designing of organic synthesis (20)
4. Umpolung in organic synthesis. (05)
5. Protection and deprotection of hydroxyl, amino, carboxyl, ketone and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide. Solid phase peptide synthesis. (08)

Books/References:

1. Modern synthetic reactions – H. O. House (Benjamin)
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
3. Designing of organic synthesis – S. Warren (Wiley)
4. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
5. Organic synthesis – M. B. Smith
6. Organometallics in organic synthesis – J. M. Swan and D. C. Black (Chapman and Hall)
7. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg 5^{th} edition (2007)

CH – 452

HETEROCYCLIC CHEMISTRY, CHIRON APPROACH & MEDICINAL CHEMISTRY (60L)

Part A: Heterocyclic Chemistry (30L)

1. Five membered heterocycles – Furan, Pyrrole and Thiophene (08)
2. Condensed five membered heterocycles – Benzofuran, Indole and Benzothiophene. (05)
3. Pyridine, Quinoline and Isoquinoline (07)
4. Rings with more than one heteroatom 1, 2 –Azoles and 1, 3-Azoles, Purines and Pyrimidines. (10)

Ref. 1, 2, 3

Part B: Chiron Approach, Medicinal Chemistry etc. (30L)

1. Introduction of sugars, structures of triose, tetrose, pentose, hexose, stereochemistry and reactions of Glucose, conformation and anomeric effects in hexoses. (04)

Ref. 4, 5

2. Chiron Approach (12)

Ref. 6

(a) Introduction

(b) Basic concepts – carbohydrates, amino acids, hydroxy acids and terpenes.

(c) The concept of chiral templates and chirons wherein the carbon skeleton is the chiral precursor.

(d) Utilisation of the basic concepts for retrosynthetic strategy and synthesis of the following – (S) Propanediol, (R) and (S) – Epichlorohydrin, L (+)-Alanine, 11-Oxaprostaglandin $F_{2\alpha}$, (-) Multistratin, (-) Pentenomycin, (-) Shikimic acid, Carbonolide B.

3. a) Green Chemistry – Basic Principles including atom economy (02)

Ref. 7

b) Supramolecular chemistry. (02)

Ref. 8

c) Medicinal chemistry: introduction, physical-chemical properties and biologic activity,

theoretical aspects of drug design (10)

Ref.9

Books:

1. Modern Heterocyclic chemistry – L. A. Paquette (Benjamin).
2. Heterocyclic chemistry – 3rd edition Raj K. Bansal, New Age International (P) Ltd. (1999).
3. Heterocyclic chemistry – J. A. Joule and K. Mills 4th edition Blackwell publishing (2007)
4. Organic Chemistry – R. P. Morrison and R. N. Boyd
5. Organic Chemistry – I. L. Finar, volume II
6. Chiron Approach in organic synthesis – S. Hanessian
7. New Trends in Green Chemistry - V. K. Ahluwalia and M. Kidwai Anamaya Publishers (2004).
8. Supramolecular Chemistry, vol.17 (1-2), pp.47-55, January-March 2005.
9. Principles of Medicinal chemistry-W.O.Foye, Ed, 2nd Ed.
   Indian edition: K.M.Verghese Company

PRACTICAL COURSES

CH – 347

TERNARY MIXTURE SEPARATION:

Separation of at least ten mixtures containing three components. The mixtures should also involve separation of nitro phenols, amino acids, low boiling substances, water soluble substances. Amines, Phenols and acids used should also contain other elements and functional groups. The mixture separation should be carried out on micro-scale using ether.

CH – 447

SINGLE STAGE AND TWO STAGE PREPARATIONS:

At least eight single stage and eight two stage preparations from the following should be carried out. The preparations should be carried out on micro scale.

Single Stage Preparations:

1. Acetophenone $\longrightarrow$ Ethyl Benzene
2. Anthranilic acid $\longrightarrow$ ortho –Iodobenzoic acid
3. Diels-Alder reaction using Anthracene and Maleic anhydride
4. Benzyl cyanide $\longrightarrow$ p-Nitro benzyl cyanide
5. Bromobenzene $\longrightarrow$ p-Nitro bromobenzene
6. 2-Naphthol $\longrightarrow$ 2,2'-Dihydroxybinaphthyl
7. Glycine $\longrightarrow$ Hippuric acid
8. Salicylic acid $\longrightarrow$ 5-Nitrosalicylic acid
9. Resorcinol $\longrightarrow$ Resacetophenone
10. 2-Methoxynephthalene $\longrightarrow$ 1-Formyl-2-methoxynaphthalene
11. p-Xylene $\longrightarrow$ Ter-phthalic acid
12. o-Nitrotoluene + Benzaldehyde $\xrightarrow{\text{Base}}$ condensation

Two Stage Preparations:

1. Benzophenone → Oxime → Benzanilide
2. Benzoin → Benzil → Benzilquinoxaline
3. Benzaldehyde + Acetophenone → Benzalacetophenone → Epoxide
4. 4-Nitrotoluene → 4-Nitrobenzoic acid → 4-Aminobenzoic acid
5. Resorcinol → 4-methyl-7-hydroxycoumarin → 4-methyl-7-acetoxy - coumarin
6. Phenol → Salicyaldehyde → Coumarin
7. Cyclohexanone → Phenylhydrazone → 1,2,3,4-tetrahydrocarbazole
8. Acetanilide → p-Nitroacetanilide → p-Nitroaniline
9. Hydroquinone → Quinone → 1,2,4- Triacetoxybenzene
10. Cyclohexanone → Oxime → Caprolactum
11. Hydroquinone → Diacetate → 2,5-Dihydroxy acetophenone
12. 4-Chlorophenol → 4-Chlorophenyl acetate → 5-Chloro-2-hydroxy-acetophenone

Interpretation of NMR, IR and Mass Spectra of about 15 compounds. Minimum 2 three stage preparations to demonstrate how to develop a synthetic sequence.

CH - 448

PROJECT AND PRACTICALS:

1. Students should carry out a small research project. This should make them familiar with literature survey, research methodologies, Identification of products by analytical and spectral methods and familiarity with chromatographic techniques.
2. Students who are not assigned the project should carry out at least 12 experiments and students who are assigned project work should carry out at least 6 experiments to illustrate the principles of organic reaction mechanism, stereochemistry or selectivity of reagents.

Suggested reagents and reactions –

$LiAlH_4$ (reduction of ethyl benzoate to benzyl alcohol),$NaBH_4$ (reduction of anisaldehyde to p-methoxy benzyl alcohol), SeO_2, NBS(bromination of p-nitrotoluene), Grignard Reaction(preparation of triphenyl carbinol or diphenyl methyl carbinol), Wittig Reaction (preparation of ethyl cinnamate from benzaldehyde), Cannizzaro's reaction (on benzaldehyde) Asymmetric reduction, Phase transfer catalyst isolation of natural products (like Eugenol from cloves, Limonene from orange peels, Trimyristin from nutmeg etc.), photochemical reaction, Peracid and lead tetra acetate oxidation, rearrangement reactions, synthesis of heterocyclic compounds like Hydantoin, thiohydantoin, pyrazolone, Biginelli reaction (synthesis of 4-aryl-3,4-dihydropyrimidinone)

Important Notes:

1. All theory and practical courses are university courses.
2. Each theory course is of 60 lectures.
3. Practicals should be carried out on micro scale.
4. Each practical course should be given six hours of laboratory work per week and the course will be extended over two semesters and will be examined at the end of the year.
5. **Practical batch will consist of not more than 10 students.**
6. At least 25 % students should be assigned the projects.
7. The weightage to the project will be of 50 marks and will be examined by the oral examination and presentation. There will be a single stage preparation of 30 marks along with project.
8. Students who are not assigned the project work have to carry out one two-stage preparation and two single stage preparations from the suggested reagents and reactions for 60 marks and undergo oral examination for 20 marks.
9. Post graduate departments should arrange at least one industrial visit.
10. All required chemicals must be made available for practicals and certified journals should be shown to the examiner.