

**SOLAPUR UNIVERSITY, SOLAPUR**  
**M. Sc. ORGANIC CHEMISTRY COURSE SYLLABUS**  
**SEMESTER SYSTEM**

A two-year duration **M. Sc. Organic Chemistry** course syllabus has been prepared as per the semester system. Syllabus for M. Sc. Part I was implemented with effect from June 2011. M. Sc. II syllabus will be implemented from June 2012. The syllabus has been prepared taking into consideration the syllabi of other Universities, SET, NET, UGC guidelines, and the specific inputs of the Expert Committee Members from Pune University, Pune, Shivaji University Kolhapur and Dr. BAMU, Aurangabad.

**General Structure of the Course:**

The course will be of four semesters spread over two academic years. Each semester will have four theory papers of 70 marks for university external examination and 30 marks for internal examination of each semester and two practicals of 70 marks, 30 marks for internal practicals of each semester. The distribution of marks is mentioned below

Theory Paper (Semester exam), 16 X 70+30 marks	1600 marks
Practicals (semester end exam.), 8 X 70+30 marks	800 marks
Seminars for each semester, 4 X 25	<u>100 marks</u>
Total:	2500 marks

Ratio of marks (Theory: Practical): (73:27)

**M. Sc. Part I\* Chemistry**

(\* This course is common for Polymer, Organic and Physical Chemistry courses).

**Semester I**

**Theory Courses:**

<b>Paper No.</b>	<b>Title of Papers</b>	
CH 101 (I)	Inorganic Chemistry-I	70+30 = (100 marks)
CH 102 (II)	Organic Chemistry-I	70+30 = (100 marks)
CH 103 (III)	Physical Chemistry-I	70+30 = (100 marks)
CH 104 (IV)	Analytical Chemistry-I	70+30 = (100 marks)

**Semester II**

<b>Paper No.</b>	<b>Title of Papers</b>	
CH 201 (V)	Inorganic Chemistry-II	70+30 = (100 marks)
CH 202 (VI)	Organic Chemistry-II	70+30 = (100 marks)
CH 203 (VII)	Physical Chemistry-II	70+30 = (100 marks)
CH 204 (VIII)	Analytical Chemistry-II	70+30 = (100 marks)

**Practical Course: (Semester end examination) Practicals I & II for semester I**  
**Practical Examination will be of 4 days for each semester**

Inorganic Chemistry Practicals:	(35 + 15)=50 marks
Organic Chemistry Practicals:	(35 + 15)=50 marks
Physical Chemistry Practicals:	(35 + 15)=50 marks
Analytical Chemistry Practicals:	(35 + 15)=50 marks

**Practicals III & IV for semester II**

Inorganic Chemistry Practicals:	(35 + 15)=50 marks
Organic Chemistry Practicals:	(35 + 15)=50 marks
Physical Chemistry Practicals:	(35 + 15)=50 marks
Analytical Chemistry Practicals:	(35 + 15)=50 marks

**M. Sc. Part II Organic Chemistry: Semester III**

**Theory Courses:**

<b>Paper No.</b>	<b>Title of Papers</b>	
ORG CH 301 (IX)	Organic Reaction Mechanism	(70 + 30) =100 marks
ORG CH 302 (X)	Advanced Spectroscopic Methods	(70 + 30) =100 marks
ORG CH 303 (XI)	Advanced Synthetic Methods	(70 + 30) =100 marks
ORG CH 304 (XII)	Drugs and Heterocycles	(70 + 30) =100 marks

**Semester IV**

<b>Paper No.</b>	<b>Title of Papers</b>	
ORG CH 401 (XIII)	Theoretical Organic Chemistry	(70 + 30) =100 marks
ORG CH 402 (XIV)	Stereochemistry	(70 + 30) =100 marks
ORG CH 403 (XV)	Chemistry of Natural Products	(70 + 30) =100 marks
ORG CH 404 (XVI)	Applied Organic Chemistry	(70 + 30) =100 marks

**Practical Course: (Semester end examination) Practicals V to VIII**

**Semester III**

P V	Organic Mixture	(70 + 30) =100 marks
P VI	i) Organic Preparation	
	ii) Spectral Problems	(70 + 30) =100 marks

**Semester IV**

P VII	Organic Preparation 40 + Estimation 30 marks + Internal 30 = 100 marks
P VIII	Project work/In-plant 50 marks + Oral 10 + Journal 10 + Internal 30 = 100 marks

**Nature of Examination:**

Each semester will have theory external examination of four papers of 70 marks each (3 hrs. duration). The practical examination of Semesters I to IV will be conducted at the end of the each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

**Practical Examination of M. Sc. I Semester I and II**

The practical examination will be of 4 days (one day for each specialization). The distribution of marks for an each specialization (50 marks) will be as under,

Practical experiments:	30
Oral	03
Journal:	02
Internal Practical	<u>15</u>
Total	50 (for each specialization practical)

**Practical Examination of M. Sc. II**

The practical examination will be of 3 days for each semester. The distribution of marks for each P V, VI, and VII is (70 marks) as under,

Practical experiments:	60
Oral	05
Journal:	05; whereas distribution of marks for P VIII will be;

Project work / In-plant training Report: 50\*\*

\*\* The valuation to be done by both external and internal examiners at the time of P VIII examination. Valuation of Seminars is to be done in each Semester by the Teaching Faculty involved in teaching Organic Chemistry course.

**Nature of question paper (for M. Sc. I and II):**

Time: 03 hours

Maxi Marks 70

**Instructions**

1. Attempt 05 questions.
2. Section I (question 1) is compulsory
3. Attempt any two questions from section II and any two questions from section III.
4. Answers to all 05 questions (from section I, II, III) should be written in the one and the same answer book.
5. All questions carry equal marks.
6. Figures to the right indicate full marks.
7. Use of log tables and calculators is allowed.

**Question Paper**  
**Section I**

Q 1. Answer the following (14 sub-questions) Marks 14 (1 x 14)  
Multiple choice / fill in the blanks / define the term / True-False, predict the product, provide the reagent and conditions etc.

Sub-questions (i) to (xiv)

**Section II**

- |      |  |                      |
|------|--|----------------------|
| Q 2. | a) - --- - - - - - - - - - -<br>b) - - - - - - - - - - - - | Marks 07<br>Marks 07 |
| Q 3. | a) - --- - - - - - - - - - -<br>b) - - - - - - - - - - - - | Marks 07<br>Marks 07 |
| Q 4. | a) - --- - - - - - - - - - -<br>b) - - - - - - - - - - - - | Marks 07<br>Marks 07 |

**Section III**

- |                                       |  |                                  |
|---------------------------------------|--|----------------------------------|
| Q 5.                                  | a) - --- - - - - - - - - - -<br>b) - - - - - - - - - - - -<br>c) - - - - - - - - - - - -                             | Marks 05<br>Marks 05<br>Marks 04 |
| Q 6.                                  | a) - --- - - - - - - - - - -<br>b) - - - - - - - - - - - -<br>c) - - - - - - - - - - - -                             | Marks 05<br>Marks 05<br>Marks 04 |
| Q 7. Write short notes on (any three) | a) - - - - - - - - - - - -<br>b) - - - - - - - - - - - -<br>c) - - - - - - - - - - - -<br>d) - - - - - - - - - - - - | Marks 14                         |

**N.B. In sections II and III, the sub-questions (a, b, and c) in a given question should be from different topics of the syllabus.**

At least 25 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.

## Paper No. ORG CH-301 (IX) - Organic reaction mechanism

### 1. Methods of determining reaction mechanism:

Kinetic & non-kinetic methods: Hammett equation, & its modification. Taft equation. (8)

### 2. Reactive Intermediates:

Arynes reactions, phosphorus, nitrogen and sulphur ylides, Methods of generation, reactivity and applications. Non classical carbocations. (8)

### 3. Study of following reactions:

Mechanism, Stereochemistry, migratory aptitude. (Application using complicated example): Mannich, Baeyer-Villiger, Chichibabin, Dienone-Phenol, Pinacol-Pinacolone, Wolff, Michael reactions and Smile's reaction. (8)

### 4. Alkylation and Acylation :

Alkylation of carbon nucleophiles, enamines, imine anions, hydrazones, enantio selectivity and stereo selectivity of alkylation. Acylation of alcohols by acyl halides by acyl imidazolides, by pyridine -2-thioesters, catalysis by DMAP. (6)

### 5. Photochemistry:

Effect of light on the rates of photochemical reactions. Types of photochemical reactions, photodissociation gas phase photolysis, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearrangements of 1,4- and 1, 5- dienes, photochemistry of carbonyl compounds, Intramolecular reactions of carbonyl compounds ,saturated cyclic and acyclic and á, â unsaturated compounds, Cyclohexadienones, Intermolecular cycloaddition reactions, dimerisation and oxetane formation. Photochemistry of aromatic compounds, Miscellaneous Photochemical Reactions, Photo-Fries reactions of anilides. Photo-Fries rearrangements. Singlet molecular oxygen reactions, Barton, HLF-reaction. Photochemistry of vision. (10)

### 6. Mechanisms in biological chemistry.

Nature's  $\text{NaBH}_4$  is a nucleotide:- Reductive amination in nature, Nature's enols-lysine enamines and coenzyme A, Rearrangements in the biosynthesis of valine and isoleucine, Hemoglobin carries oxygen as an iron (II) complex. (clayden book). (5)

### Books suggested:

1. A guide book to Mechanism in Organic Chemistry (Orient- Longmens)- Peter Sykes
2. Organic Reaction Mechanism (Benjamin)-R. Bresslow
3. Mechanism and Structure in Organic Chemistry(Holt Reinhartwinston)- B. S. Gould
4. Organic Chemistry (McGraw Hill)-Hendrikson, Cram and Hammond
5. Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio.
6. Reactive intermediates in Organic Chemistry 9 Jojn Wiley) N. S. Issacs.
7. Organic reaction mechanism ( Mc Graw Hill) R. K. Bansal
8. Fundamentals of Photochemistry K. K. Rohragi-Mukherji Wiley-Eastern
9. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott. Blackwell Scientific Publication.

10. Molecular Photochemistry, N. J. Urro, W. A. Benjamin.
11. Introductory Photochemistry U. A. Cox and T. Camp Mc Graw-Hill
12. Photochemistry R. P. Kundall and A. Gilbert. Thomson Neison.
13. Organic Photochemistry J. Coxon and B. Hallon Cambridge University press
14. Advanced organic chemistry, part B:Reaction and synthesis by Francis A. Carey,  
Richard Y. Sandburg.
15. Organic Chemistry by Clayden, Greeves, Warren and Wothers.

## Paper No. ORG CH 302 (X): Advanced Spectroscopic methods

### 1. IR Spectroscopy

Characteristic vibrational frequencies of alkanes; alkenes; alkynes; aromatic compounds; alcohols; ethers; phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds such as ketones; aldehydes; esters; amides; acids; anhydrides; lactones; B-lactam and conjugated carbonyl compounds etc. Effect of hydrogen bonding and solvent effect on vibrational frequencies; overtones; combination and Fermi resonance bands. FTIR, of gases; solids and polymeric materials. (6)

### 2. $^1\text{H}$ NMR

Recapitulation of basic principle, Fourier Transform technique, Pulse sequence, relaxation processes. Use of Integration in the quantitative determination of isomers, Factors affecting chemical shifts (inductive, resonance and anisotropic effect with examples), chemical shift of different types of protons (alkane, alkene, alkyne and allene), aromatic protons and effect of substituent, different types of spin coupling, first order analysis of spectra, Ramsay mechanism of spin coupling, roofing effect with example, different spin systems (AB, AM, AX, ABX/AMX spin systems with examples), calculations of line intensities and chemical shifts in AB spin system, factors affecting coupling constants (dihedral angle, Karplus equation-graph, electronegativity, bond order, hybridization, bond angle with examples), non equivalence due to restricted rotations, rate processes. Effect of high field NMR for simplification of spectra, Shift reagents. Spin decoupling and Nuclear Overhauser effect with examples. Resonance of other nuclei-F; P. (12)

### 3. $^{13}\text{C}$ NMR

Elementary ideas, instrumental difficulties, FT technique advantages and disadvantages. Proton Noise Decoupling technique advantages and disadvantages, off-resonance technique, Chemical shifts of solvents, factors affecting chemical shifts, analogy with  $^1\text{H}$  NMR, calculations of chemical shift of hydrocarbons, effect of substituents on chemical shifts, different types of carbons (alkene, alkyne and allene), chemical shift of aromatic carbons and effect of substituent. Chemical shifts of carbonyl, nitrile, oxime carbons. (8)

### 4. Two dimensional (2D)

NMR techniques, principle and pulse technique, DEPT with 3 different angles,  $^1\text{H}$ - $^1\text{H}$  COSY,  $^1\text{H}$ - $^{13}\text{C}$  COSY (HETCOR, HMQC, HMBC, HSQC), interpretation of 2D spectra and examples. (8)

### 5. Mass spectrometry

Theory, instrumentation various methods of ionization (field ionization, FAB, MALDI, californium plasma), different detectors [magnetic analyzer, ion cyclotron analyzer, quadruple mass filter, time of flight (TOF)]. Importance of HRMS, Rules of fragmentation of different functional groups, factors controlling fragmentation. Fragmentation of different types of compounds like alkanes alkenes, aromatic compounds, carbonyl compounds, nitriles etc. (8)

## 6. Problems

Based on joint application of UV, IR,  $^1\text{H}$  and  $^{13}\text{C}$  NMR, 2D and Mass (including reaction sequence). (3)

### Books:

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3<sup>rd</sup> Ed. (Harcourt college publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6<sup>th</sup> Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry – D. H. Williams and I. Fleming 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. 4<sup>th</sup> Ed. John Wiley and sons Ltd.
10. NMR spectroscopy of Organic compounds. Jackmann and Sternhell S.
11. Spectroscopy: Donald L. Pavia, Gary M. Lampman.

## Paper No.ORG CH-303 (XI) - Advanced Synthetic methods

### 1. Disconnection approach

An introduction to Synthons and synthetic equivalents, disconnection approach, functional group inter conversions, the importance of the order of events in organic synthesis, Regioselectivity, one group C-X and two group disconnections, chemoselectivity, reversal of polarity, (Umpolung), Cyclisation reactions, Amine synthesis. (10)

### 2. Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl groups. i.e. Methods of protection and deprotection of alcohol, amines, carboxyl and carbonyl groups. (8)

### 3. Transitional metals complexes in organic synthesis

(A.) Palladium Heck arylation, allylic activation, carbonylation, wacker oxidation, isomerization formation N-aryl and N-alkyl bond transmetalation, allyl deprotection in peptides, coupling reactions: Stille coupling, Sonogashira and Suzuki coupling reactions and their importance (6)

(B) **Iron:-** Reactions of Iron carbonyls, ferrocenes, Fe-cyclopentadiene complex, protection of dienes, isomerization (2)

(C) **Mn & Co:-** Manganese and Co-carbonyls in hydroformylation, carboxylations, synthesis of silane complexes and their applications Pausal-khand reactions and its applications protection of alkynes by  $\text{Co}_2\text{CO}_8$  (2)

**4. Organoboranes:-** preparation and properties of organoborane reagents e.g.  $\text{RBH}_2$ ,  $\text{R}_2\text{BH}$ ,  $\text{R}_3\text{B}$ , 9-BBN, catechol borane. Thexyl borane, cyclohexyl borane,  $\text{ICPBH}_2$ ,  $\text{IPC}_2\text{BH}$ , Hydrboration-mechanism, stereo and regeoselectivity, uses in synthesis of primary, secondary tertiary alcohols, aldehydes, ketones, alkenes. Synthesis of EE, EZ, ZZ dienes and alkyenes. Mechanism of addition of  $\text{IPC}_2\text{BH}$ . Allyl boranes- synthesis, mechanism and uses (8)

5. Synthesis and uses of organo silane and organo tin compounds (2)

### 6. Application of following reagents & reaction in synthesis wilkinsons catalyst,

Lithium dialkyl cuprate, lithium diisopropylimide(LDA), Trimethyl silyl iodide, tributyl tin hydride, peracids, PPA, ozone, Selenium dioxide, periodic acid, Iodoisobenzyl diacetate. (7)

### RECOMMENDED BOOKS

1. S. Warren: Designing of Organic synthesis
2. J. Fuhrhop & G. Benzlin. : 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.REALAND: Organic synthesis
9. Bartan and Ollis: Comprehensive organic Chemistry
10. R. Admas: - Organic reactions
11. Stone & West: Advances in organometallic Chemistry
12. C. W. Bird: Transition metal intermediate in organic synthesis
13. Swan & Black: Organometallics in Organic synthesis.
14. A. Mitre: Synthesis of Prostaglandin's
15. 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 catalyzed reactions T. W. Green & P.G. M. Wats: Protecting groups in Organic Chemistry
19. T.Shona: Electro-organic Chemistry
20. Weber & Gokel: Phase transfer catalyst in organic synthesis.
21. Protecting Group chemistry J. Robertson (OX.).
22. Modern synthetic reactions – H. O. House (Benjamin)
23. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
24. Designing of organic synthesis – S. Warren (Wiley)
25. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
26. Organic synthesis – M. B. Smith
27. Organometallics in organic synthesis – J. M. Swan and D. C. Black (Chapman and Hall)
28. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg 5th edition (2007)
29. Palladium in Organic Synthesis Richard Heck
30. Organonickel compounds, Jolly
31. Comprehensive organometallic chemistry-Vol. 1-8
32. Chiron approach in organic synthesis – S. Hanessian (Relevant chapters For Chirons)
33. Aromaticity , P. Garratt
34. Carbocyclic non-benzenoid aromatic compounds, D. Lloyd

## Paper No. ORG CH 304 (XII) - Drugs and Heterocycles

### 1. Drug Design

Development of new drugs, procedures followed in drug design, concepts of prodrugs and soft drugs, factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. History and development of QSAR, Concepts of drug receptors, applications of computers in drug design, Molecular modeling, Applications of combinatorial Chemistry in drug design. (5)

### 2. Study of the following type of drugs:

- a. **Antibiotics:** Preparation of semi synthetic penicillin, conversion of penicillin into cephalosporin, general account of tetracycline and macaracyclic antibiotics. (no synthesis)
- b. **Antomalarials:** Trimethopim, role of folic acid and its inhibition, mechanism of cell wall synthesis and inhibition.
- c. **Analgesic and antipyretics;** Paracetamol, Meperidine, Methadone, Aminopyrine
- d. **Anti-inflammatory;** Ibuprofen, Oxyphenbutazone, Dichlorophenac, Indomethacin, Arachidonic acid.
- e. **Antitubercular and anti leprotic;** Ethanbutol, Isoniazide, Dasone, mechanism, Pathways, inhibition of cyclooxygen.
- f. **Anaesthetics;** Lidocaine, Thiopental, mechanism of action.
- g. **Antihistamines;** Phenobarbiton, Fenediazole, Diphenylhydramine, mechanism of action.
- h. **Tranquistisers:** Diazepam, Trimeprazin, mechanism of action.
- i. **Anti AIDS drugs:** Cause, antimetabodies and anti-AIDS drugs.
- j. **Cardiovascular Drugs: Synthesis** of dilliazem, quindine, methyl dopa, atenolol, Oxyproprenol
- k. **Anti-neoplastic drugs:** Cancer chemotherapy, alkylating agents, mitotic inhibition, carcinolytic antibiotics and antimetabiotics, mode of action and synthesis of some important drugs. (20)

## Heterocycles

### 3. Small Ring Heterocycles

Three-membered and four-membered heterocycles-synthesis and chemical reactions of aziridines, oxiranes, thiranes, azetidines, oxitanes and thietanes. (8)

### 4. Five Membered Heterocycles

Synthesis and reactions including medicinal applications of furan, pyrrole, thiophene and benzopyrroles, benzofurans and benzothiophenes, imidazole, oxazole, thiazole, pyrazoles. (8)

### 5. Six- Membered Heterocycles

Synthesis and reactions of pyridine, quinolines, isoquinoline, purines, pyrimidines, coumarins and chromones, triazines. (4)

### **Books Suggested**

1. Burger: Medicinal Chemistry
2. A . Kar: Medicinal chemistry (Wiley East )
3. W. O. Foye: Principals of medicinal chemistry
4. Wilson, Gisvold and Dirque: Text book of Organic medical and pharmaceutical Chemistry
5. Pharmaceutical manufacturing encyclopedia
6. R. M. Acheson: An introduction to chemistry of heterocyclic compounds (Interscience)
7. Joule and Smith: Heterocyclic chemistry (Van Nossstrand)
8. R.K. BANSAL: Heterocyclic chemistry (Wiley E)
9. L.A. Paquette: Principals of modern heterocyclic chemistry
10. M.H. Palamer: The structure and reactions of heterocyclic compounds.
11. A.R. Katritzky and A.V. Boulton : Advances in Heterocyclic chemistry (A.P.)
12. Finar : Organic chemistry (Vol. 1 and 2)
13. Conn and Stumpf : Outline of Biochemistry
14. Williams, Introduction to the chemistry of enzyme action.
15. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman Academic Press.
16. Strategies for Organic Drug Synthesis and Design. D. Lednicer, John Wiley.
17. Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar, and V. Gupta, Springer Verlag.
18. The Chemistry of Heterocycles, T Eicher and S. Hauptmann, Thieme.
19. Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
20. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical
21. Contemporary Heterocyclic Chemistry, G. R. Newkome and W. W. Paudler, Wiley.
22. An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley.
23. Comprehensive Heterocyclic Chemistry, A. R. Katritzky and C. W. Rees, eds, Pergamon Press.
24. Introduction to Medicinal Chemistry, Alex Gringuaz

## SEMESTER-IV (Organic Chemistry)

### Paper No-ORG CH-401 (XIII): Theoretical Organic Chemistry

#### **1. Molecular Orbital Theory:**

Aromaticity in benzenoids, alternant and non- alternant hydrocarbons, **Huckel,s** rule, energy level of pi molecular orbitals and concept of Aromaticity, Calculation of energies of orbitals in cyclic and acyclic systems. Determination energies and stabilities of different systems. Calculation of charge densities. PMO theory and reactivity index. **(10)**

#### **2. Non benzenoid aromatic Compounds:**

Aromaticity in Non- benzenoids compounds, **Annulenes** and hetroannulenes, fullerene C<sub>60</sub>, Tropone, tropolone azulene, fulvene, tropylium salts, ferrocene, three and five membered systems. Crown ether complexes, cyclodextrins, cryptands, catenanes and rotaxanes, bonding in fullerenes. **(10)**

#### **3. Kinetic and thermodynamic control of reactions:**

Reactions of naphthalene, Wittig reaction, Enolization, Friedel Crafts reations, Diels Alder reations, **(4)**

#### **4. Reactions of carboxylic acids and esters**

Types of hydrolysis mechanisms catalyzed by acids and bases. **(3)**

#### **5. Free radical reactions:**

Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at aromatic substrates, neighboring group assistance. Reactivity for aliphatic and aromatic substitution at a bridgehead. Reactivity in attacking radicals. The effect of solvent on reactivity. Allylic hydrogenation (NBS), Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyers reaction. Free radical rearrangement, Hunsdiecker reaction. **(8)**

#### **6. Pericyclic Reactions:**

Molecular orbital symmetry, Frontier orbital of ethylene, 1,3 -butadiene, 1,3,5 -hexatriene and allyl system. Classification of pericyclic reaction, Wood-ward Hoffman correlation diagrams. FMO and PMO approach, Electrocyclic reactions, - conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloaddition , and supra and antrafacial additions, 4n and 4n+2 systems, 2+2 additions of ketenes, 1,3- dipolar cycloaddition and chilotropic reactions, sigmtropic rearrangement , supra and antrafacial shifts of H Sigmatropic shifts involving carbon moieties, 3,3 - and 5,5 -Sigmatropic rearrangement and Claisen and Cope and Aza-Cope rearrangement and Ene reaction. **(10)**

**Recommended Books:**

1. Lehar and Merchand: Orbital Symmetry
2. R. B. Woodward and Hoffman: Conservation of Orbital symmetry.
3. Kan: Organic Photochemistry
4. Cixon and Halton : Organic photochemistry
5. Arnold: Photochemistry
6. N. Turro : Modern Molecular Photochemistry
7. Rohatgi- mukherji : Fundamentals of photochemistry.
8. Ginsburg: Nionbenzoid aromatic compound
9. A. Streitwieser : Molecular orbital theory for organic chemistry.
10. E. Cler : The aromatic sextet.
11. Lloyd: Carbocyclic non- benzoid aromatic compounds.
12. G. M. Bandger ; The structure and reactions of aromatics compounds
13. W. B. Smith; Molecular orbital methods in Organic Chemistry.
14. Grratt: Aromaticity.

## Paper No. ORG CH- 402 (XIV): Stereochemistry

### 1. Newer methods of Stereoselective synthesis:

Introduction and Stereoselective and stereospecific reactions. Enantioselective synthesis (Chiral approach) reactions with hydride donors, hydroboration, catalytic hydrogenation via chiral hydrazones and oxazolines, Sharpless epoxidation, Diels-Alder selective synthesis, enantiotopic and diastereotopic atoms, groups and faces. Asymmetric synthesis: use of calculations of optical purity and enantiomeric excess.(12)

### 2. Conformation and reactivity in acyclic compounds and of cyclohexanes.

Stability and reactivity of diastereoisomers. Curtin- Hammett principle. (6)

### 3. Some aspects of the stereochemistry of ring systems:

Stereoisomerism, Determination of configuration, Stability of rings and ease of rings formation. (5)

### 4. The shapes of the rings including six membered:

Shapes of five, and seven eight membered rings, Reactivity of six member ring system, Conformational effects in medium sized rings, Concept of I strain.(7)

### 5. Fused and Bridged rings: Fused bicyclic ring systems:

Cis- and trans- decalins and nine methyl decalines and perhydropheanthrene, perhydroanthracene. Bridged rings, Nomenclature stereo chemical restrictions. The Bredts rule, Reactivities.(6)

### 6. Stereochemistry of Allenes, spiranes and biphenyls :

Assignment of configuration. (4)

### 7. Configuration of diastereomers based on Physical and Chemical methods (4)

### Recommended Book:

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.

## Paper No. ORG CH-403 (XV): Chemistry of Natural Products

1. Structure, stereochemistry, synthesis and biogenesis of Hardwickiic acid, Camptothecin and Podophyllotoxin. ( Ref. 1 to 4 and 11) **(10)**

2. **Structure determination and Synthesis** of 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. **(15)**

3. **Biogenesis** – The building blocks and construction mechanism of  
(i). Terpenoids – Mono, Sesqui, Di and Triterpenoids and cholesterol  
(ii) Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan.  
(iii) The Shikimate pathway – cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbers, isoflavanoids and terpenoid quinones. Ref. 8, 9, 10.  
(iv) Arachidonic acid – Prostaglandins & thromboxanes. **(12)**

4. **Biological Functions and mechanisms** – involving vit. B1, B2, B6, Biotin, Folic acid, NAD/NADP-NADH/NADPH, Riboflavin. **(8)**

### Books:

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 and E.J. Sorensen
7. J. Indian Inst. Sci. 81, 287 (2001).
8. Medial Natural Products – A Biosynthetic approach by Paul M. Dewick 2<sup>nd</sup> edition (Wiley)
9. Secondary metabolism – J. Mann, 2<sup>nd</sup> 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).
12. Apsimon : The Total synthesis of natural products.
13. Manskey and Holmes : Alkaloids
14. A.A. Newmen : Chemistry of Terpenes.
15. P. D B.Mayo : The Chemistry of natural products.
16. Simonson : Terpenes.
17. T.W. Goddwin : Aspects of terpenoid chemistry and biochemistry
18. Woguer : Vitamins and Co- enzymes.
19. Bently : Chemistry of natural products,
20. Fieser and Fieser : Steroids
21. Finar : Organic chemistry Vol. II and I
22. J.B. Hendrickson : The molecules of nature.
23. Peter Bernfield : The biogenesis of natural products,
24. R.T. Slickenstaff A.C. Ghosh and G.C. Wole : Total synthesis of steroids.
25. The Chemistry of natural products : by Nakanishi

## Paper No. ORG CH- 404 (XVI): Applied Organic Chemistry

### 1. Application of the following in synthesis

Merrifield resin, Polymeric reagents. Solid phase synthesis of polypeptide & oligonucleotides, electro-organic synthesis, enzyme catalyzed reaction in synthesis. (12)

**2. Green Chemistry:-** (i) Introduction and basic principles (ii) multicomponent reactions. (iii) Applications of Microwave and Ultrasonication in Organic Synthesis (iv) Reactions in aqueous media (v) Use of ionic liquids. (12)

**3. Supramolecular Chemistry** (Crown ethers, Cyclodextrins, entrimers, Clalixerins) (6)

### 4. Advanced Carbohydrate Chemistry

Introduction of sugars, structures of triose, tetrose, pentose, hexose. Fisher projection, D- and L-configuration, Conversion of Fisher projection to furanose and pyranose form, Haworth Structure,  $C_1^4$  and  $C_4^1$  Conformations, anomeric effect, Reactions of five and six carbon sugars, glycoside formation, acetonide formation, reduction, synthesis of D-glyceraldehyde, Killani-Fischer Synthesis, glucal formation and reactions, Ferrier and Hanesian Reaction, Ferrier rearrangement. (15)

### Books:

1. Organic Chemistry – R. P. Morrison and R. N. Boyd
2. Organic Chemistry – I. L. Finar, Volume –II
3. New Trends in Green Chemistry – V. K. Ahluwalia and M. Kidwai Anamaya Publishers (2004).
4. Supramolecular Chemistry vol. 17 (1-2), pp. 47-55, January-March 2005.
5. Modern synthetic reactions – H. O. House (Benjamin)
6. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
7. Designing of organic synthesis – S. Warren (Wiley)
8. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
9. Organic synthesis – M. B. Smith
10. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg 5th edition (2007)

## M. Sc. II Organic Chemistry Practicals: Practicals V-VIII

### A) Qualitative Analysis

Separation, purification and identification of compounds of THREE components  
Mixtures, chemical tests. Derivatives etc.

### B) IR spectra to be used for functional group identification. TLC and Column Chromatography.

### C) Quantitative analysis

Colorimetric and pH metry experiments.

### D) Three stage Organic preparations starting with 5g or less. (TLC Analysis is recommended)

1. Preparation of Benzanilide by Beckmann rearrangement.
2. Preparation of Anthranilic acid.
3. Preparation of Phthalimide.
4. Preparation of N- Bromosuccinamide.
5. Preparation of p- Aminobenzoic acid.
6. Preparation of p- chloronitrobenzene by Sandmeyer reaction.
7. Preparation of p- Iodonitrobenzene by Sandmeyer reaction.
8. Pinacol- Pinacolone rearrangement.
9. Preparation of Acetophenones by Fries rearrangement
10. Preparation of aromatic aldehydes by Vilsmer Hack reaction or R. T.
11. Wittig reaction.

(Other suitable experiments may be added)

### E) Estimation of sulphur, nitrogen and functional groups, pharmaceutical analysis. Polyfunctional analysis.

**F) Project:** Literature survey. Studies of reactions, synthesis, mechanism, isolation of natural products, standardization of reaction conditions, new methods etc..

**G).** Experiments as per requirement may be added.

### Books:

1. A Textbook of Practical Organic Chemistry - A. I. Vogel.
2. Practical Organic Chemistry - Mann & Saunders.
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.
5. Reagents in Organic Synthesis by Fieser and Fieser.
6. Organic Practicals by Ahluwalia.
7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).