# North Maharashtra University

'A' Grade NAAC Re-Accredited (3rd Cycle)

Jalgaon-425001, Maharashtra, (India)

## B.O.S. in Chemistry

## M.Sc. Second Year (Organic Chemistry)

## Semester III & IV

With effect from **June-2018**

## NORTH MAHARASHTRA UNIVERSITY, JALGAON

## Syllabus for M.Sc. Part-II Organic Chemistry

(Semester - III & IV)

(With Effect from June 2018)

**Aims:**

Chemistry is a central subject of science. It is also closely related to daily life. The broad aims are to help students to

1. Acquire some knowledge of the empirical world.
2. Acquire an ability to solve problem.
3. Acquire an ability to think scientifically, independently and to make rational discussion.
4. Acquire an ability to communicate, using the language of chemistry.
5. Develop an appreciation of chemistry and its application in daily life.

**Objectives:**

1. To encourage students to take an active part in class.
2. To teach good laboratory practice and skills.
3. To teach students to analyze data from experiments or from other sources.
4. To acquire students a readiness in becoming responsible citizens in a changing world.
5. To provide students with some insight into future career prospect in the fields related to Chemistry.

### Course Structure for Second Year

The following will be the structure for revised syllabus from June 2018 for Semester III and Semester IV

### SEMESTER - III

Sub. Code: Title

CH-350: Organic Reaction Mechanism

CH-351: Spectroscopic Methods in Structure Determination

CH-352: Organic Stereochemistry

CH-353: Free radical, photochemistry, Pericyclic reaction and their applications

### SEMESTER - IV

Sub. Code: Title

CH-450: Chemistry of Natural Products

CH-451: Synthetic Methods in Organic Chemistry

CH-452: Heterocyclic chemistry, Chiron approach and medicinal chemistry

### Practical courses:

Sub. Code: Title

CH -O-2: Ternary mixture separation (Annual)

CH -O-3: Three stage preparations (Annual)

CH -O-4: Short Research Project (Annual)

## Important Notes

1. Each theory course prescribed for M. Sc. should be covered in 4 lectures, each of 60 minutes duration per week per course including lectures, tutorials, seminars etc. (Total 60 hrs / theory course)

2. Each practical course will require 6 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. (Total 180 hrs / practical course)

3. There should not be more than 10 students in a batch for M. Sc. Practical course.

4. For theory course the question paper should include at least 20 % weightage for problem solving. Problem solving would include numerical, short answer, long answer questions to test understanding of the subject.

5. Of the 60 lectures in each course about 10 lectures will include tutorials, student seminars, classroom discussions and tests.

6. The marks for each paper are distributed as external examination 60 marks and internal examination 40 marks. For internal assessment of each theory and practical course, 2 written tests will be taken in which best will be considered for internal marks.

7. Students should visit at least two chemical industries in two years of M. Sc. and submit the observations/report to the Department.

**SEMESTER-III**

## CH-350: ORGANIC REACTION MECHANISM (60L)

**1. Physical Organic Chemistry: (18 L)**

**1.1. Acids and Bases: Factors affecting acidity and basicity:** Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.

**1.2. Determining mechanism of a reaction:** Product analysis, kinetic studies, use of isotopes (Kinetic isotope effect – primary and secondary kinetic isotope effect). Detection and trapping of intermediates, crossover experiments and stereochemical evidence.

**1.3. Linear free energy relationship:** Hammett plot, Hammett equation, substituent and reaction constants, physical significance of substituent constants and reaction constants, substituent constant involving through conjugation. Use of Hammett plot and equation. Deviations from straight line plot. Concave upward deviation. Concave downward deviation. Dual parameter correlations, Inductive substituent constants. The Taft model, σI and σR scales, steric parameters Es and β. Solvent effects.

**Ref. 1, 2, 3, 4 (relevant pages)**

**2. Reactive Intermediates and Concerted Reactions (Carbocation, Carbene, Nitrene, and Arynes) (10 L)**

Organic reactive intermediates and their structure, methods of generation, structure, stability and important reactions involving carbocations, nitrenes, carbenes, arynes.

**Ref. 1,2,3,4,5 (relevant pages)**

**3.The neighboring group mechanism (05 L)**

The neighboring group mechanism, neighboring group participation by π and σ bonds, anchimeric assistance. Non-classical carbocations, phenonium ions, norbornyl system,

**Ref. 1, 2, 4, 6 (relevant pages)**

**4. Aromaticity: (05 L)**

Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. Application of HMO theory to monocyclic conjugated systems. Frost-Musulin diagrams. Huckel's (4n+2) and 4n rules. Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, azulenes, tropolones, fulvenes, sydnones, annulenes, aromatic ions and Fullerene (C60).

**Ref. 2, 4 (relevant pages)**

**5. Ester hydrolysis and decarboxylation: (10 L)**

Classification, nomenclature and study of all eight mechanisms of acid and base catalyzed hydrolysis with suitable examples.

Decarboxylation reaction.

**Ref. 3, 6 (relevant pages)**

**6. Reaction of carbon nucleophiles with carbonyl groups: (12 L)**

**Carbanions**: Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. Alkylation of aldehydes, ketones, esters, amides and nitriles. Chemistry of enolates and enamines, Kinetic and Thermodynamic enolates, Lithium and boron enolates in aldol and Michael reactions, Alkylation and acylation of enolates, Nucleophilic additions to carbonyls and stereochemical aspects through various models (Cram / Cram chelation / Felkin-Anh models); Organolithium, Organomagnesium, Organozinc, Organocopper reagents (restricted to 1,4-addition) in synthesis,

Recall of Name reactions, their Mechanism and regiochemistry in the reactions under carbanion chemistry - Claisen, Dieckmann, Knoevenegal, Stobbe, Darzen, Acyloin & Benzoin condensations, Shapiro reaction, etc. with regioselectivity and stereoselectivity.

**Enamines**: Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines.

**Ref. 1, 2, 3, 4, 5, 6, 7 (relevant pages)**

**References:**


1. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure,
3. Mechanism in Organic Chemistry, Peter Sykes, 6th
4. Advanced Organic Chemistry Part A and B 2nd edition, by F. A. Carey and R. J. Sundberg. Plenum Press. New York and London.
5. Modern methods of organic synthesis – W. Carruthers (Cambridge)
6. Mechanism and structure in Organic Chemistry, Edwin S. Gould, Holt, Rinechart and Winston.
7. Stereochemistry of carbon compounds. E L. Eliel.
8. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, Pearson Publication (7th Edition)
9. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.
10. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.
11. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.
12. Organic synthesis – M. B. Smith
13. Reactions, Rearrangements and Reagents by S. N. Sanyal
14. Name Reactions, Jie Jack Li, Springer
15. Lowry. T. H. & Richardson, K. S. Mechanisms and Theory in Organic Chemistry Addison-Wesley Educational Publishers, Inc (1981)

# CH-351: Spectroscopic Methods in Structure Determination

**1. Proton Magnetic Resonance: (12 L)**

**Unit I:**

**A) $^{1}$H-NMR Spectroscopy**: **(14 L)**

Advanced ideas of chemical shift, factors influencing chemical shift, Shielding & deshielding, chemical exchange, effect of deuteration (Driving force), spin-spin coupling, (n+1) rule, Stereochemistry, hindered rotation, vicinal and germinal coupling, long range coupling, factors affecting coupling constant "J"., identification of complex spin-spin interaction between two, three, four and five nuclei (first order spectra), classification of spin system like AB, AX, $AX_2$, ABX, AMX, ABC, $A_2B_2$. Simplification of complex spectra, nuclear magnetic double resonance, spin decoupling, shift reagents, solvent effects, nuclear over-hauser effect (NOE)
Magnetic Resonance Imaging (MRI): Introduction, working and Applications

**B)** Two dimensional NMR spectroscopy, 2D-HETCOR, $^{1}H^{1}H$ COSY, types of COSY experiments

**Unit II: Introduction to NMR Spectroscopy of some other Nuclei $^{15}$N, $^{19}$F, $^{31}$P and D and $^{11}$B. (04L)**

**Unit III: $^{13}$C NMR spectroscopy**: **(12L)**

Types of $^{13}$C NMR Spectra: Proton decoupled, un-decoupled, Off resonance, chemical shift, calculations of chemical shifts of aliphatic, olefin, alkyne, aromatic, heteroaromatic and carbonyl carbons, chemical shift features of hydrocarbons, effect of substituents on chemical shifts, factors affecting chemical shifts, Homo nuclear($^{13}$C-$^{13}$C) and Hetero nuclear ($^{13}$C-$^{1}$H) coupling constants.

**Unit IV: Mass Spectrometry**: **(12L)**

Instrumentation, various methods of ionization (field ionization, field desorption, SIMS, FAB, MALDI, Californium plasma), different detectors [magnetic analyzer, ion cyclotron analyzer, Quadrupoule mass filter, time of flight (TOF)]. Mass Spectral fragmentation of Organic compounds containing common functional groups, McLafferty rearrangement, Molecular Ion peak, metastable peak, isotope peaks, Examples of Mass spectral fragmentation of Organic compounds with respect of their structure determination.

**Unit V: Problems: (18L)**

a) Problems based on joint application of U.V., I.R., NMR, CMR and Mass spectroscopy
b) Determination of structure of organic compounds from U.V., I.R., NMR, CMR and Mass spectra [Spectral Interpretation of compound containing maximum ten (10) carbon atoms]

**References:**

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).5
9. Organic structures from spectra –Field L.D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.
10. Organic Spectroscopy(NMR, IR, Mass, and UV) – S.K. Dewan, CBS Publishers & Distributors Pvt. Ltd
11. Organic spectroscopy-William kemp, E L B with McMillan
12. Spectroscopy of organic molecule-PS Kalsi,Wiley, Esterna, New Delhi
13. Spectroscopy in organic chemistry-C N R Rao and J R Ferraro

## CH-352: Organic Stereochemistry

**1. Principles in streoechemistry: (12 L)**

A) Selectivity, enantioselectivity, diastereoselectivity, chemoselectivity, regioselectivity, determination of enantiomeric/diastereomeric excess, determination of optical purity, Racemic modificationand methods for resolution of racemic modification.

B) Conformations of acyclic organic molecules (alkanes, alkenes, alcohol, aldehydes, ketones, esters and dienes)

**Ref 1, 4, 5, 6, 7 & 9**

**2. Asymmetric synthesis and its applications: (18L)**

Asymmetric synthesis with chiral substrates - Cram's rule, FelkinAnh rule, Cram's chelate model, use of chiral auxiliaries, chiral reagents and catalysts in asymmetric synthesis.

stereoselective aldol reactions (Zimmermann traxler model), asymmetric hydrogenation (BINAP), asymmetric epoxidation (+DET/-DET) and asymmetric dihydroxylation (DHQD) 2PHAL/(DHQ) 2PHAL

**Ref 3, 7, 8, 9, 10 & 11**

**3. Stereochemistry of six membered rings (saturated/unsaturated) & their reactions: (10 L)**

Different shapes of cyclohexane and substituted cyclohexane ring, reactions associated with cyclohexyl skeleton.

Mono, disubstituted cyclohexane-physical properties (optical activity/energetics),

Sstereochemistry of cyclohexene and concerned reactions.

Conformations in six member heterocyclic ring (O/N/S)

**Ref:1, 4, 5, 6, 7 & 9**

**4. A) Stereochemistry of ring other than six membered (08 L)**

Conformations of smaller, medium and larger rings,trans annular effect e, concept of I-strain. Conformational effects in larger rings, Anti butane segment, and allied reactions.

**Ref 1, 4, 5, 6, 7 & 9**

**B) Determination of stereochemistryoforganic compounds using NMR (04 L)**

**Ref 3 & 9**

**5. stereochemistryofFused ring and Bridge rings (Bicyclic & polycyclic) (08L) .**

**Ref 1, 2, 4, 5 & 9**

References:


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 1st. Ed.
4. Stereochemistry of organic compounds –Nasipuri
5. Stereochemistry of organic compounds-Kalsi
6. Organic stereochemistry – Jagdamba Singh
7. Basic stereochemistry of organic moleculsSubrata Sen Gupta(Oxford)
8. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
9. Stereochemistry, D. G. Morris, , RSC Tutorial Chemistry Text 1, 2001
10. Stereoselective synthesis—MihalyNograd VCH, Weinheim, 1995.
11. Principles and applications of Asymmetric Synthesis—Gou-Qiang Lin, Yue-Ming Li and S. C. Chan---Wiley-Interscience, John Wiley and Sons, Inc. Publication 2001.


## CH-353: Free radical, photochemistry, Pericyclic reaction and their applications

**1. Free Radicals: 15 L**

Formation, stability, types of free radical reactions, free radical substitution mechanism, cyclization mechanism, mechanism at an aromatic substrate, neighbouring group assistance and effect of solvent on reactivity.

Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto oxidation, coupling of alkynes, arylation of aromatic compounds by diazonium salts, Sand-meyer reaction, free radical rearrangement and Hunds-diecker reaction.

**2. Photochemistry 25 L**

**2.1 Introduction to Basic Principles of Photochemistry**

Jablonski diagram, Fluorescence and Phosphorescence, Delayed Fluorescence, Quantum yield, Solvent effect, Stern-volmer plot, Photosensitization and Quenching process.

**2.2 Photochemistry of carbonyl compounds**

Nature of transition ($n \longrightarrow \pi^*$, $\pi \longrightarrow \pi^*$, d-d transition and Charge transfer), Norrish type-I and Norrish type-II reaction, abstraction of γ-hydrogen in cyclic and acyclic compounds,

formation of bicyclic and tricyclic compounds, Paterno-Buchi reaction (including reaction of enones, ynones and quinones), allenes, Photoreduction (toluene and 2-propanol)

**2.3 Photochemistry of alkene**

Intermolecular and intramolecular reactions, geometrical isomerization, Cyclization reactions, rearrangements of 1,4 and 1,5 dienes, Dimerization, Hydrogen abstraction, addition , Di-pi methane rearrangement including aza-di-pi methane.

**2.4 Photochemistry of aromatic compounds**

Isomerization, additions and substitutions.

**2.5 Reactions:** Photofries reactions, Barton reactions.

**3. Pericyclic Reactions** **20 L**

**3.1 Introduction**

Classification, Molecular orbital symmetry properties, three approaches: Co-relation diagram, FMO & PMO or ATS approach.

**3.2 Electrocyclic reactions**

Con rotatory & Dis rotatory motions, 4n and 4n+2 & allyl system.

**3.3 Cycloaddtion reactions**

Antarafacial & suprafacial additions, 4n, 4n+2 systems, Diels-Alder reaction and its stereochemistry, 2+2 addition of ketones, secondary orbital interaction in cycloaddition reaction, 1,3-dipolar cycloaddition and chelotropic reactions.

**3.4 Sigmatropic rearrangement**

Suprafacial & antarafacial shifts of H and carbon moities, Claisen, Cope & aza cope, Ene reactions and Fluxional molecule.

**3.5 Application of pericyclic reactions**

Synthesis of Vit- D from 7-dehydrocholesterol.

**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. Photochemistry and Pericyclic reaction- Jagamba Sing, Jaya Singh 3rd Ed.
5. Organic photochemistry: A visual approach-Jan Kopecky, VCH publishers (1992).
6. Excited states in Organic Chemistry- J. A. Barltrop and J. D. Coyle, John Wiley & sons
7. Conservation of orbital symmetry – R. B. Woodward and R. Hoffmann; Verlag chemie, weinheim (1970).
8. Orbital Symmetry : A problem solving approach- R. E. Lehr and A. P. Marchand; Academic (1972).
9. Organic reactions and orbital symmetry, 2nd Ed. T. L. Gilchrist and R. C. Storr; Cambridge University Press.
10. Classics in total synthesis- K. C. Nicolaou and E. J. Sorensen; VHC (1996)
11. Synthetic Organic Photochemistry- Axel G. Griesbeck, Jonchen Mattay, Marcel Dekker NY.

## SEMESTER-IV

## CH-450: Chemistry of Natural Products

**1) Secondary Metabolism: 18 L**

Natural products, primary and secondary metabolism, metabolites derived from mevalonates metabolites derived from Shikimic acid, secondary metabolism of amino acids.

**2) Chemistry of Natural Products 10 L**

Structure, stereochemistry & biogenesis of Hardwickiic acid, Prostagandin: Classification, general structure, biological importance, Structure elucidation & total synthesis of PGE1

**3) Synthesis of Some Natural Products 12 L**

i) Reserpine (Woodward synthesis) ii) Taxol

iii) Estrone iv) Strychnine (Overman's synthesis)

v) Fredericamycin A vi) Juvabione

**4) Vitamins 12L**

Classification, sources and biological importance of vitamin B1, B2, B6, folic acid, B12, C, D1, E (α-tocopherol), K1, K2, H (β- biotin), synthesis of the following:

Vitamin B1 including synthesis of pyrimidine and thiazole moieties

Vitamin B2 from 3, 4-dimethylaniline and D(-)ribose

Vitamin B6 from: Ethoxyacetylacetone and cyanoacetamide

Vitamin E (α-tocopherol) from trimethylquinol and phytyl bromide

Vitamin K1 from 2-methyl-1, 4-naphthaquinone and phytol.

**5. Enzymes 08L**

Chemistry of enzymes: Introduction, nomenclature, classes and general types of reactions catalyzed by enzymes. Properties of enzymes: i) Enzyme efficiency/catalytic power ii) Enzyme specificity; Fischer's 'lock and key' and Koshland 'induced fit' hypothesis. Concept and identification of active site.

Factors affecting enzyme kinetics: Substrate concentration, enzyme concentration, temperature, pH, product concentration etc. Reversible and irreversible inhibition

***References*:**


1. Secondary Metabolism, J. Mann, 2nd Edition (Oxford University Press).
2. Chemical Aspects of Biosynthesis – J. Mann (1994).
3. Biosynthesis of Natural Products. P. Manitto
4. i) Tetrahedron Letter No.49, pp. 3751-3759, 1964. Pergamon Press Ltd. Printed in Great Britain. ii) Tetrahedron vol.35 Pages 2301-2310
5. Chemistry of Natural Products: S. V. Bhatt, B. A. Nagasampagi, M. Shivakumar, Narosa Publications
6. Organic Chemistry-Vol.2, 5th edition-I. L. Finar
7. Chemistry of Natural Product by P.S.Kalsi
8. Principles of Organic Synthesis by R. O. C. Norman and J.M.Coxon; Chapman and Hall 6.
9. Classics in Organic Synthesis – K. C. Nicolaou & E. J. Sorensen
10. Enzyme catalysis in organic synthesis, 3rd edition. Edited by Karlheinz Drauz, Harold

Groger, and Oliver May, Wiley-VCH Verlag G. & Co K., 2012.
11. Biochemistry, Dr U Satyanarayan and Dr U Chakrapani, Books and Allied (P) Ltd.
12. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
13. The Organic Chemistry of Enzyme-Catalysed Reactions, Academic Press, By Richard B. Silverman
14. Enzymes: Practical Introduction to structure, mechanism and data analysis, By Robert A. Copeland, Wiley-VCH, Inc.
15. The Organic Chemistry of Biological Pathways By John McMurry, Tadhg Begley by Robert and company publishers
16. Principles of Biochemistry, M. M. Cox & D. L. Nelson, Lehninger, 5th ed.
17. Pawson, B. A.; Cheung, H.-C.; Gurbaxani, S.; Saucy, G. *J. Am. Chem. Soc.* **1970**, *92*,336-343. (Juvabione synthesis)

## CH-451: Synthetic Methods in Organic Chemistry

1. **Applications of following elements in organic synthesis : (20)**

   B (Hydroboration, Carbonylation), Si (Uses of Oraganosilane, Brook rearangment, Peterson's Olefination), Ni (Uses of Nickel carbonyl ,$Ni(COD)_2$), Pd (Heck, Suzuki, Stille, Sonogashira, Negishi, Buchwald- Hartwig couplings, Wacker process), Pt (Hydrogenation), Rh (Wilkinson's Catalyst and applications), Ru (Grubb's Catalyst, only Ring closing & Ring Opening metathesis), Co (Oxo process, Pauson Khand Reaction, Vollhardt co-trimerization)

   **Ref.: 2, 4, 6 & 7**

2. **a) Umpolung reactivity in organic synthesis. (03)**

   **b) Nitrogen, Phosphorous and Sulphur ylides organic synthesis. (04)**

   **Ref.: 2, 4, & 9**

3. **Designing of organic synthesis: (16)**

   Disconnection Approach: An introduction to synthons and synthetic equivalents, functional group interconversions.

   **One group Disconnections** :Disconnections of simple alcohols, simple olefins ,Aryl ketones, control, Disconnections of simple ketones & acids, Two group Disconnections : 1,3-Dioxygenated skeletons,-β-hydroxy carbonyl compounds, α-β unsaturated carbonyl compounds,1,3 dicarbonyl compounds,1,5 dicarbonyl compounds –Use of Mannich reaction

   **Two group Disconnections** : The 1,2 Dioxygenation pattern –α -hydroxy carbonyl compounds,1,2 diols, Illogical electrophiles ,1,4 Dioxygenation pattern - 1,4 dicarbonyl compounds ,γ hydroxy carbonyl compounds, other illogical synthons ,1,6 dicarbonyl compounds, pericyclic reactions , Heteroatoms & heterocyclic compounds

   **Linear and Convergent Synthesis**

   **Ref.: 2 & 3**

4. **Protecting groups in Organic Synthesis: (07)**
   Protection & deprotection of hydroxyl, carbonyl, amino and carboxylic acid functional groups & its applications. Solid phase peptide synthesis.
   **Ref.: 2, 8 & 9**
5. **Some Advanced Synthetic Reactions. (10)**
   **a) Click chemistry:** Introduction, Criteria for Click reaction. Sharpless azides cycloadditions
   **b) Olefination reactions:** Tebbe, McMurry, Julia-Lythgoe, Nysted.
   **c) Fragmentaion reactions:** Eschenmoser, Grob.
   **d) Some other reactions:** Mitsunobu, Nef, Staudinger.
   **Ref.: 2, 10 & 11**

**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 & Hall)
7. Organic Synthesis, Jagdamba Singh and L.D.S. Yadav
8. Modern Organic Synthesis an Introduction –G.S. Zweifel and M. H. Nantz
9. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
10. www.organicchemistryportal.com
11. www.synarchive.com


## CH-452: Heterocyclic Chemistry, Chiron Approach and Medicinal Chemistry

**UNIT 1: Heterocyclic Chemistry- Synthesis and Reactions (30 L)**

i. Five Member Heterocycles- Furon, Pyrrol and Thiophine. (08 L)
ii. Condensed five member heterocycles- Benzofuran, Indol, Benzothiophine. (05L)
iii. Six memberfed heterocycle :Pyrridine, (02L)
iv. Quinoline and Isoquinoline. (05L)
v. Ring more than one heteroatom- 1,2 Azoles , 1,3 Azoles, Purines and Pyrimidines. (10L)

**UNIT 2: CHIRON APPROACH**

Introduction Basic concepts –Carbohydrates, amino acid , hydroxyl acids and terpenes. The concept of chiral templates and Chirones where in the carbon skeleton is the chiral precursor.Utilization of the basic concepts for retro synthetic strategy and synthesis of-**a)** (-) Pentenomycin. **b)** (R) and (S) Epichlorohydrin, **c)** (-) Multistriatin **(06L)**

**UNIT 3: INTRODUCTORY ASPECTS IN MEDICINAL CHEMISTRY (10L)**

Classification , Nomenclature, Sources, Concepts of prodrugs and soft drugs, Receptor, Therapeutic index, Bioavailability, Drug assay and Drug potency.Concept and definition of Pharmacophore. Basic pharmacokinetics: drug absorption, distribution, metabolism (biotransformation) and elimination, Pharmacodynamics, –. Drug targets: enzymes and receptors. Competitive, non-competitive inhibitors , Physical and chemical parameters like solubility, lipophilicity, ionization, pH, redox potential, H-bonding, partition coefficient and isomerism in drug distribution and drug –receptor binding. Factors affecting Absorption, Distribution, Metabolism, Elimination and Toxicity.Structure-activity relationships.

**UNIT 4: DRUG DISCOVERY, DESIGN AND DEVELOPMENT**. (**08L)**

Procedures in drug design:

Drug discovery without a lead: Penicillin

Lead discovery: random screening, non-random (or targeted) screening.

Lead modification: Identification of the pharmacophore, Functional group modification, Structure-activity relationship, Structure modification to increase potency and therapeutic index: Homologation, chain branching, ring-chain transformation, bioisosterism, combinatorial synthesis.

**UNIT 5: SYNTHESIS AND PHARMACOLOGICAL ACTION OF FOLLOWING CLASS OF DRUGS (06)**

| | | |
|---|---|---|
| **Anticancer** | **:** | eg**.** Fluorouracil |
| **Antihypertensive** | **:** | eg. Metaprolol |
| **Anti-inflammatory** | **:** | eg. Ibuprofen |
| **Antibiotics** | **:** | eg. Ampicilline |
| **Antidiabetics** | **:** | eg Troglitazone |

**References:**


1. Modern Heterocyclic Chemistry- L.A. Paquette
2. Heterocyclic Chemistry 3rd Ed.- Raj Bansal (New age Publi.)
3. Heterocyclic Chemistry 4th Ed.- J.A. Joules and K. Mills (Blackwell Publi.)
4. Organic Chemistry – R.P. Morrison and R.N. Boyd (LPE)
5. Organic Chemistry-I.L.Finar Vol-II
6. Chiron Approach in Organic Synthesis- S. Hanessain
7. Pharmaceutical Chemistry and Drug Synthesis- Rot and Kleeman.
8. Drug Design – E.J. Arienes
9. Medicinal Chemistry- Foye
10. Medicinal Chemistry- Ashutosh Karr
11. Medicinal Chemistry – G R. Chatwal.
12. Medicinal Chemistry- by V. K. Ahluwalia and Madhu Chopra, (Ane books India)
13. Introduction to Medicinal Chemistry by Graham L. Patrick 5$^{th}$ Edition Oxford

**Semester IV: Practical's**

## Course Code: CH-O-2

**Separation of ternary mixture using micro-scale technique (Minimum 8 experiments)**

1. Separation of components of ternary mixtures based upon differences in the physical and the chemical properties of the components.
2. Purification of the three components monitored by TLC and determination of their physical constants.

## Course Code: CH-O-3

**Three stage preparations (Starting with 5g or less.)Monitored by TLC**

***Prep-1: Synthesis of Anthranilic acid from phthalic acid***

Step 1: Phthalic acid to phthalic anhydride (Dehydration)
Step 2: Phthalic anhydride to phthalamide (Amide formation)
Step 3: Phthalamide- Anthranilic acid (Hoffman's reaction)

***Prep -2: Synthesis of Acridone from Anthranilic acid***

Step 1: Anthraninilc acid to o-chlorobenzoic acid (Diazotosation followed by sandmayer's)
Step 2: o-chlorobenzoic acid to N-phenyl anthranilic acid (Substitution)
Step 3: N-phenyl anthranilic acid to acridone (Cyclisation)

***Prep -3: Synthesis of Paracetomol from Nitrobenzene***

Step 1: Nitrobenzene to N-phenyl hydroxylamine (reduction)
Step 2: N-phenyl hydroxyl amine to *p*-aminophenol (*Bamberger* Rearrangement)
Step 3: *p*-amino phenol to *p*-hydroxy acetanilide/paracetomol (acetylation)

***Prep -4: Synthesis of P-Nitro Aniline from Aniline***

Step 1: Aniline to Acetanilide (Acetylation)
Step 2: Acetanilide to P- Nitroacetanilide (Nitration)
Step 3: P- Nitroacetanilide to P-Nitroaniline (Hydrolysis)

***Prep -5: m-Chloro-Nitrobenzene from m-Dinitrobenzene***

Step 1: *m*-dinitrobenzene to *m*-nitro aniline (partial reduction)
Step 2: *m*-nitro aniline to *m*-nitrodiazoniumchloride (diazotization)
Step 3: *m*-nitrodiazoniumchloride to *m*-Chloro-nitrobenzene (sandmayers reaction)

***Prep -6: Synthesis of p-Bromo Benzanilide from Benzophenone***

Step 1: Benzophenone to benzopenone oxime (Addition)
Step 2: Benzophenone oxime to benzanilide (Beckman's rearrangement)
Step 3: Benzanilide to *p*-bromobenzanilide (Bromination)

***Prep -7: Synthesis of Methyl Orange from Aniline***
Step 1: Aniline to sulphanilic acid (sulphonation)
Step 2: sulphanilic acid to Diazonium chloride (diazotization)
Step 3: Diazonium chloride to methyl orange (coupling reaction)

***Prep -8:synthesis of Benzilic acid from Benzaldehyde***
Step 1: Benzaldehyde (using thiamine HCl) to Benzoin (condation)
Step 2: Benzoin to Benzil (oxidation)
Step 3: Benzil to Benzilic acid (rearrangement)

**All the students must submit the TLC for all the stages of preparation and a photo copy must be pasted in records.**

REFERENCES:
1. Practical Organic Chemistry A.I.Vogel (Longmans)

2. Text Book of practical organic Chemistry F.G.Mann & B.C. Sanders.

3. A Manual of Practical Organic Chemistry Day Sitaramam & Govindachari

4. Organic Experiments L.F.Fieser.

5. Practical Organic Chemistry H.T.Openshaw

6. Systematic Identification of Organic Compounds, P.L.Shriner, R.C.Fuson & D.Y.Curtin.

7. Identification of Organic Compounds N.D.Cheronis & J.B.Entrilkin

8. Advanced Organic Synthesis by R.S.Monson Academic Press
9. Comprehensive Practical Organic Chemistry: By V.K. Ahluwalia, R. Aggarwal, V.K. Ahluwalia

## CH -O-4: Short Research Project

**Literature survey, study of reactions, synthesis, mechanism, isolation of natural products, standardization of reaction conditions, new methods etc.**

1. Project allotted to 100% students.
2. Industrial visit is compulsory for all students.
3. CH-O-4 course is annual.
4. 60 marks for External examination.

Marking Scheme:

i. Content – 10 mark
ii. Characterization – 10
iii. Research Work- 20
iv. Power point presentation- 10 mark
v. Result and Observation-10 mark

**5.** 40 marks internal examination.

Marking Scheme:

i. Literature Survey- 10
ii. Review Writing – 10
iii. Presentation-10
iv. Industrial Visit Report-10

**6.** Student should submit review report and visit report at the time of annual practical examination.

| M.Sc. Part-II Organic Chemistry (Semester - III & IV)<br>subject equivalency between New and Old syllabus | | | |
|---|---|---|---|
| NORTH MAHARASHTRA UNIVERSITY, JALGAON<br>Syllabus for M.Sc. Part-II Organic Chemistry<br>(Semester - III & IV)<br>**(With Effect from June 2018)**<br>Course Structure for Second Year<br>The following will be the structure<br>for revised syllabus from June 2018 for<br>Semester III and Semester IV | | NORTH MAHARASHTRA UNIVERSITY, JALGAON<br>Syllabus for M.Sc. Part-II Organic Chemistry<br>(Semester - III & IV)<br>**(With Effect from June 2015)**<br>Course Structure for Second Year<br>The following will be the structure<br>for revised syllabus from June 2015 for<br>Semester III and Semester IV | |
| Subject code | TITLE | Subject code | TITLE |
| **SEMESTER – III** | | **SEMESTER – III** | |
| CH-350 | Organic Reaction Mechanism | CH-350 | Organic Reaction Mechanism |
| CH-351 | Spectroscopic Methods in Structure Determination | CH-351 | Spectroscopic Methods in Structure Determination |
| CH-352 | Organic Stereochemistry | CH-352 | Organic Stereochemistry |
| CH-353 | Free radical, photochemistry, Pericyclic reaction and their applications | CH-353 | Free radical, photochemistry, Pericyclic reaction and their applications |
| **SEMESTER – IV** | | **SEMESTER – IV** | |
| CH-450 | Chemistry of Natural Products | CH-450 | Chemistry of Natural Products |
| CH-451 | Synthetic Methods in Organic Chemistry | CH-451 | Synthetic Methods in Organic Chemistry |
| CH-452 | **Heterocyclic chemistry, Chiron approach and Medicinal chemistry** | CH-452 | **Heterocyclic chemistry, Chiron approach, Chiral drugs and Medicinal chemistry** |
| **ANNUAL** | | **ANNUAL** | |
| CH-O-2 | Ternary mixture separation | CH-O-2 | Ternary mixture separation |
| CH-O-3 | Three stage preparations | CH-O-3 | Three stage preparations |
| CH-O-4 | Short Research Project | CH-O-4 | Short Research Project |