Deccan Education Society's

FERGUSSON COLLEGE (Autonomous), PUNE - 411004

Two Years
M. Sc. Degree Course in Chemistry
(Organic Chemistry)

SYLLABUS
Semester III and IV

Second Year M. Sc.
[Organic Chemistry]

[Academic Year-: 2017-2018]

Deccan Education Society's

FERGUSSON COLLEGE (Autonomous), PUNE - 411004

Department of Chemistry

Two Years M. Sc. Degree Course in Chemistry

[Implemented from Academic Year 2017-2018]

M. Sc. Part II Organic Chemistry Course Structure under CBCS (Autonomy)
Course Structure:

Semester	Course Code	Title of the Course	Credits	Core / Elective	Internal / External
III	CHO5301	Reaction Mechanism in Organic Chemistry	4	Core	I / E
	CHO5302	Structure Determination by Analytical Methods	4	Core	I / E
	CHO5303	Stereochemistry of Organic Molecule	4	Core	I / E
		Elective Papers: Any Two			
	CHO5304	Designing of Organic Synthesis	2	Elective	I / E
	CHO5308	Chemistry of Heterocycles	2	Elective	I / E
	CHO5309	Applications of Heterocyclic Compounds	2	Elective	I / E
	CHO5305	Organic Chemistry Practical V	4	Core	I / E
	CHO5306	Organic Chemistry Practical VI	4	Core	I / E
	CHO5307	Self Learning Course 3 Literature survey in Chemistry	1	Core	I
IV	CHO5401	Chemistry of Natural Products	4	Core	I / E
	CHO5402	Advanced Synthetic Organic Chemistry	4	Core	I / E
	CHO5403	Asymmetric Synthesis	4	Core	I / E
		Elective Papers: Any Two			
	CHO5404	Carbohydrate as Chirons in Chiral Drugs Synthesis	2	Elective	I / E
	CHO5408	Medicinal Chemistry	2	Elective	I / E
	CHO5409	Agrochemicals	2	Elective	I / E
	CHO5405	Organic Chemistry Practical VII	4	Core	I / E
	CHO5406	Organic Chemistry Practical VIII	4	Core	I / E
	CHO5407	Self Learning Course 4 Chemistry in everyday life	1	Core	I

Deccan Education Society's

Fergusson College (Autonomous), Pune – 411004

Faculty of Science

Extra Credits for Post Graduate Courses M.Sc. II

M. Sc. Course in Organic Chemistry

Semester	Course Code	Title of the Course	No. of Credits
III	XCS0007	Introduction to Cyber Security/Information Security	1
	XSD0008	Skill Development	1
IV	XCS0009	Introduction to Cyber Security/Information Security	1
	XSD0010	Skill Development	1
		Total	**4**

Semester III

Course Code: CHO5301
Course Title: Reaction Mechanism in Organic Chemistry
(4 Credits)

Reaction Mechanism in Organic Chemistry:

Objectives:

1. To understand the concept of formation of organic intermediates and their reactions: carbanion, enamines, carbene, nitrene.
2. Details study of different neighboring group participation in organic chemistry.
3. To study mechanisms in biological chemistry.
4. Explore to Hammet equation and its application.
5. Study of different mechanisms of acid hydrolysis.

Unit I	Carbanions and dicarbanions - Formation, stability and related name reactions	**(12 L)**
Unit II	Enamines and ynamines: Formation, stability and applications	**(6 L)**
Unit III	Reactions of carbenes:, *N*-heterocylcic carbene and nitrenes-generation, stability and reactivity	**(8 L)**
Unit IV	Neighbouring group participation	**(16 L)**
Unit V	Free radical - Generation, stability, Nucleophilic and electrophilic radicals, characteristics reactions, -free radical substitution, addition to multiple bonds, Radicals in synthesis: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors, cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds, Oxidative coupling, C-C bond formation in aromatics, SNAr reactions, Mechanisms in biological chemistry	**(10 L)**
Unit VI	Ester and amide hydrolysis (only major acid, base catalyzed and neutral condition mechanisms)	**(8 L)**

References:

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. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)
4. A guidebook to mechanism in organic chemistry – Peter Sykes 6th Ed. Orient Longman
5. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers. Oxford University Press (2001)
6. Radicals in Organic Synthesis B. Giese, Pergamon press (1986)
7. Physical Organic chemistry – J. Hine
8. A guidebook to mechanism in organic chemistry – Peter Sykes 6 Th Ed. Orient Longman
9. The Hammett equation – C. D. Johnson, Cambridge University Press (1973)
10. Chemistry of Carbanions by Stovel

Course Code: CHO5302
Course Title: Structure Determination by Analytical Methods
(4 Credits)

Objectives:

1. Introduction of spectroscopic principles.
2. To study different techniques in spectroscopy.
3. To study organic structure analysis.
4. To determine structure from spectra.
5. To learn spectroscopic identification of organic compounds.
6. To learn interpretation of different types of spectra.
7. To get knowledge of one and two dimensional NMR spectroscopy.
8. To study applications of Mass spectrometry

Unit I	**^{1}H-NMR Spectroscopy**: History of NMR, Chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and mercaptans), chemical exchange, effect of deuteration (Driving force), spin-spincoupling, (n+1) rule, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), factors effecting coupling constant "J", classification of spin system like AB, AX, AX_2, ABX, AMX, ABC, A_2B_2. Spin decoupling, 4Factors affecting coupling constant, simplification of complex spectra, nuclear magnetic double resonance, spin decoupling, contact shift reagents, solvent effects, nuclear over-hauser effect (NOE), resonance of other nuclei like ^{31}P, ^{19}F	**(14 L)**
Unit II	**^{13}C NMR spectroscopy**: FT NMR, Types of ^{13}C NMR Spectra: un-decoupled, Proton decoupled, Off resonance, APT, INEPT, DEPT, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts, Homo nuclear (^{13}C-^{13}C) and Hetero nuclear (^{13}C-^{1}H)coupling constants.	**(12 L)**
Unit III	**2D NMR Techniques**: General idea about two dimensional NMR spectroscopy, Correlation spectroscopy (COSY)-Homo COSY (^{1}H-^{1}H), TOCSY, Hetero COSY (HMQC, HMBC), Homo and Hetero nuclear 2D resolved spectroscopy, NOESY and 2D-INADEQUATE experiments and their applications.	**(12 L)**
Unit IV	**Mass Spectrometry**: 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). Rules of fragmentation of different functional groups, factors controlling fragmentation, HRMS.	**(12 L)**
Unit V	Problems based on joint application of UV, IR, PMR, CMR, and Mass (Including reaction sequences)	**(10 L)**

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. 4^{th} Ed. John Wiley and sons Ltd.
10. Spectroscopic identification of organic compound-R M Silverstein,G C Bassler and T C Morril, John Wiley
11. Introduction to NMR spectroscopy-R J Abrahm, J Fisher and P loftus Wiley
12. Organic spectroscopy-William kemp, E L B with McMillan
13. Spectroscopy of organic molecule-PS Kalsi,Wiley, Esterna, New Delhi
14. Organic spectroscopy-RT Morrison and RN Boyd
15. Practical NMR spectroscopy-ML Martin, J J Delpench, and D J Martyin
16. Spectroscopic methods in organic chemistry-D H Willson, I Fleming
17. Spectroscopy in organic chemistry-C N R Rao and J R Ferraro
18. NMR –Basic principle and application-H Guntur
19. Interpretation of NMR spectra-Roy H Bible
20. Mass spectrometry organic chemical applications, J H Banyon

Course Code: CHO5303
Course Title: Stereochemistry of Organic Molecule
(4 Credits)

Objectives:

1. To study stereochemical aspects of six membered and other ring systems.
2. Stereochemistry of fused and bridged rings systems.
3. Concept of racemic modification and methods to achieve it.
4. Applying various principles of stereochemistry in different reactions.
5. Stereochemistry of natural compounds and principles of ORD and CD
6. To understand principles of Pericyclic reactions and their applications.

Unit I	Stereochemistry of six membered rings and reactions thereof. Ref. 1, 6, 7	**(12 L)**
Unit II	Stereochemistry of rings other than six membered. Ref. 1, 6, 7	**(5 L)**
Unit III	Fused Bridged and caged rings, Baldwin'S Rule. Ref. 1, 2, 6, 7	**(10 L)**
Unit IV	Resolution of racemic modification – Dynamic and kinetic resolution. Ref. 1, 6, 7	**(8 L)**
Unit V	Stereochemistry of Morphine, Quinine and Lactone Fusion in Enhydrin including principles of ORD, CD. Ref. 4, 5, 6	**(10 L)**
Unit VI	Pericyclic reactions: Electrocyclic, cycloaddition, sigmatropic and ene reactions. 1,3-dipolar additions, Analysis by correlation diagrams, FMO approach and ATS concept. Application of pericyclic reactions. Ref. 8 to 15	**(15 L)**

References:

1. Stereochemistry of carbon compounds - E. L. Elie
2. Stereochemistry of carbon compounds - E. L. Elie l and S. H. Wilen
3. Chemistry of Natural Products – N. R. Krishnaswa my (University Press)
4. Organic Chemistry vol. II - I. L. Finar, 5^{th} edition (Longman)
5. Stereochemistry of organic compounds –Nasipuri
6. Stereochemistry of organic compounds-Kalsi
7. Organic stereochemistry – JagdambaSingh
8. Advanced Organic Chemistry, Part A – F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)
9. Conservation of orbital symmetry – R. B. Woodward and R. Hoffmann; Verlag Chemie, Academic press (1971).
10. Orbital Symmetry : A problem solving approach- R. E. Lehr and A. P. Marchand; Academic (1972)
11. Organic reactions and orbital symmetry, 2nd Ed. T. L. Gilchrist and R. C. Storr; Cambridge, University Press.
12. P. A. Wender and J. J. Howbert J. Am. Chem. Soc. 103, 688-690 (1981)
13. Pericyclic reactions: A text book –S. Sankararaman
14. Pericyclic reactions- Gill and Willis
15. Frontier orbitals and organic chemical reactions-Ian Fleming, John Wiley & sons

Elective Course

Course Code: CHO5304
Course Title: Designing Organic Synthesis
(2 Credits)

Objectives:

1. Use retrosynthetic analysis is to work out and compare alternative syntheses of complex organic molecules.
2. Outline important classical and modern reactions used in organic synthesis.
3. Discuss the design of synthetic routes, choice of reagents and conditions taking into account cost, safety and environmental factors.
4. Discuss the problems involved in process development and the scale up of synthesis of commercially important compounds.
5. Use of protection and de-protection in organic synthesis.

Unit I	**Designing Organic Synthesis:** Retrosynthesis, Protection and de-protection of hydroxyl, amino, carboxyl, ketone and aldehyde functions, Umpolung in organic synthesis.	**(30 L)**

References:

1. Designing of organic synthesis – S. Warren (Wiley)
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers
3. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)

Course Code: CHO5308
Course Title: Chemistry of Heterocycles
(2 Credits)

Objectives:

1. Know the most important simple heterocyclic ring systems containing one and two heteroatoms and their systems of nomenclature and numbering and their importance in biological systems.
2. Understand, in general terms, the reactivity and stability of heteroaromatic compounds.
3. Know the main synthetic routes and reactivity for variety of heterocycles.

Unit I	**Chemistry of Hetrocycles:** Five and six membered heterocycles with one and two hetero atoms: Furan, Pyrrole, Thiophene, Pyridine, Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidines Condensed five and six membered heterocycles with one and two hetero atoms: Benzofuran, Indole, Benzo-[*b*]-thiophene, Quinoline, Isobenzofuran, Isoindole, Benzo-[*c*]-thiophene, Isoquinoline, Benzoxazole, Benzthiazole, Benzimidazole Five and six membered heterocycles with more than two hetero atoms: 1,2,3-Triazole, 1,2,4-Oxadiazole, 1,2,5-Oxadiazole, Tetrazole, Purine	**(30 L)**

References:

1. Heterocyclic Chemistry - T. Gilchrist
2. An introduction to the chemistry of heterocyclic compounds - R M Acheso
3. Heterocyclic Chemistry - J A Joule and K Mills
4. Principles of modern heterocyclic chemistry - A Paquette
5. Heterocyclic Chemistry - J A Joule and Smith
6. Handbook of Heterocyclic Chemistry - A R Katritzky, A F Pozharskii
7. Heterocyclic Chemistry-II - R R Gupta, M Kumar, V Gupta, Springer (India)

Course Code: CHO5309
Course Title: Applications of Heterocylic compounds
(2 Credits)

Objectives:

1. To study various applications of heterocylces.

Unit I	**Applications of Heterocylic compounds:** Heterocylcles in Pharmaceutical industry Heterocycles in polymers and agrochemicals	**(30 L)**

References:

1. Heterocyclic Chemistry - T. Gilchrist
2. An introduction to the chemistry of heterocyclic compounds - R M Acheso
3. Heterocyclic Chemistry - J A Joule and K Mills
4. Principles of modern heterocyclic chemistry - A Paquette
5. Heterocyclic Chemistry - J A Joule and Smith
6. Handbook of Heterocyclic Chemistry - A R Katritzky, A F Pozharskii
7. Heterocyclic Chemistry II - R R Gupta, M Kumar, V Gupta, Springer (India)

Course Code: CHO5305
Course Title: Organic Chemistry Practical Course V
(4 Credits)

Single Stage Preparations (Any Fifteen)

1. 2-Phenyl indole (Fischer indole synthesis),
2. 7-Hydroxy -3-methyl flavone (Baker-Venkatraman reaction),
3. Benzyl alcohol and benzoic acid from benzaldehyde (Cannizzaro reaction)
4. 4-Iodobenzoic acid from 4-Amino benzoic acid (Sandmeyer reaction)
5. Benzilic acid from benzoin (Benzilic acid rearrangement)
6. Benzopinacol (Photochemical reaction),
7. 7-Hydroxy-4-methyl coumarin (Pechmann Reaction)
8. 4-Methyl benzophenone (Friedal Craft reaction)
9. Benzanilide (Beckmann rearrangement)
10. Vanillyl alcohol from vanillin (NaBH4 reduction)
11. 2- and 4-nitrophenols (nitration and separation by steam distillation)
12. Stilbene from benzyl chloride (Wittig reaction)
13. Ethyl cinnamate from benzaldehyde (Wittig reaction)
14. Triphenyl or diphenyl methyl carbinol (Grignard reaction)
15. Benzotriazole
16. 1-Phenyl-3-methyl pyrazol-5-one
17. Glucose pentaacetate
18. 2,4-diethoxycarbonyl-3,4-dimethyl pyrrole from ethyl acetoacetate
19. Quinoline from aniline Skraup synthesis)
20. Benzimidazole from o-phenylene diamine
21. Cyclohexanol from cyclohexanone (LAH reduction)
22. 2-(1-hydroxycyclohexyl)-2-phenylacetonitrile from Benzyl cyanide
23. Ethyl 6-methyl-2-oxo-4-phenyl-1,2,3,4-tetrahydropyrimidine-5-carboxylate from benzaldehyde
24. Benzoyl glycine $\rightarrow$ 4-Benzylidene-2-phenyloxazol-5-one

References:

1. Practical organic chemistry by Mann & Saunders
2. Text book of practical organic chemistry –by Vogel
3. The synthesis, identification of organic compounds –Ralph L. Shriner, Christine K.F. Hermann, Terence C. Morrill and David Y. Curtin

Course Code: CHO5306
Course Title: Organic Chemistry Practical Course VI
(4 Credits)

Two Stage Preparations (Any Eight)

1. Benzaldehyde → Benzalacetophenone → Epoxide
2. 4-Nitro toluene → 4-Nitro benzoic acid → 4-Amino benzoic acid
3. Resorcinol → 4-methyl-7-hydroxy coumarin → 4-Methyl-7-acetoxy coumarin
4. Cyclohexanone → Phenyl hydrazone → 1,2,3,4-Tetrahydrocarbazole
5. Hydroquinone → Hydroquinone diacetate → 1,2,4-Triacetoxy benzene
6. Acetanilide → *p*-Acetamidobenzene sulphonyl chloride → *p*-Acetamidobenzene sulphonamide
7. *p*-Amino phenol → *p*-Acetyl amino phenol → *p*-Ethoxy acetanilide
8. Hippuric acid → Azalactone → 4-Benzylidene 2-phenyl oxazol-5-one
9. *p*-Cresol → *p*-Cresyl benzoate → 2-Hydroxy-5-methyl benzophenone
10. Phthalimide → *N*-Benzylphthalimide → Benzylamine
11. *o*-Nitroaniline → *o*-Phenylene diamine → Benzimidazole
12. Phthalic acid → Phthalimide → Anthranilic acid
13. Benzyl cyanide → *p*-Nitrobenzyl cyanide → *p*-Nitro phenyl acetic acid
14. Hydroquinone → Hydroquinone diacetate → 2,5-Dihydroxy acetopheneone
15. Cyclohexanone → Enamine → 2-Acetyl cyclohexanone
16. α-Pinene → Disiamyl borane → Pinanol
17. Acetanilide → *p*-Bromoacetanilide → *p*-Bromoaniline
18. Chlorobenzene →2,4–dinitrobenzene → 2,4-dinitrophenol
19. 4-Metylacetanilide → 2–Bromo-4-methylacetanilide → 2–Bromo-4-methylaniline
20. Acetophenon → Oxime → Acetanilide
21. Antranilic acid → Indolone → Indigo (Air oxidation)
22. Anthranilamide → *N*-Acetylanthranilamide → Benzopyrimidone
23. Phthalimide → 1*H*-benzo[*d*][1,3]oxazine-2,4-dione → quinazolin-4(3*H*)-one
24. Cyclohexanone →1-cyclohexylidene-2-phenylhydrazine → 6,7,8,9-tetrahydro-5H-carbazole
25. P- Toluidine → N-P- tolyacetamide → N-(2-Bromo-4-methyphenyl) acetamide → 2-Bromo-4-methylbenzenamine
26. Methyl-2-aminobenzoate → Methyl 2-acetamidobenzoate → 2-methylquinazolin-4(3H)-one
27. Glycine → Acetylglycine → 4-Benzylidene-2-methyloxaxol-5-one → α-Acetamidocinnamic acid
28. Glycine → Benzoyl glycine → 4-Benzylidene-2-phenyloxazol-5-one

Course Code: CHO5307
Course Title: Self-Learning Course - III (Literature survey in Chemistry) (1 Credit)

Literature survey in Chemistry

Objectives

1. To understand scientific methods for searching chemical literature
2. To get familiar with software tools required for such survey
3. To analyze Plagiarism
4. Introduction to chemistry research journals

Use of computer browsing for literature search and downloading –basics of internet services – various sources of abstracts ,articles and papers of browsing and downloading, Techniques of conversion from one format to another Structure drawing programs and their uses –searches through structure. Use of Literature, Knowledge of National and International Journals, Impact Factor, Citation-Index, h Index, SCI Journals, Plagiarism.

Reference:

1. Pubmed
2. Scifinder
3. Sciencedirect
4. Highwire publication
5. Googlescholar
6. Reaxys
7. Scirus.com

Semester IV

Course Code: CHO5401
Course Title: Chemistry of Natural Products
(4 Credits)

Objectives:

1. To study structural determination of some biologically active molecules
2. To study determination of stereochemistry of some biologically active molecules
3. To study the retrosynthetic analysis of important natural products
4. To study the synthesis of important natural products
5. To study various building blocks in synthesis natural products.
6. To study biogenesis of various oxygen and nitrogen containing natural products.

Unit I	Structure and stereochemistry of Hardwickiic acid, Camptothecin and podophyllotoxin. Ref. 1 to 4 and 11	**(12 L)**
Unit II	Synthesis of a. Taxol Ref. 6 b. Estrone and Mifepristone Ref. 6, 7 c. Juvabione (K.Mori and Matsui, Pawson and Cheung Synthesis) Ref.12 d. Fredericamycin A Ref. 5	**(24 L)**
Unit III	Biogenesis – The building blocks and construction mechanism of a. Terpenoids – Mono, Sesqui, Di and Triterpenoids and cholesterol b. Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan. c. The shikimate pathway – cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbens, isoflavanoids and terpenoid quinones. Ref. 8, 9, 10	**(24 L)**

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. Medicinal Natural Products - A Biosynthetic approach by Paul M. Dewick 2nd Ed.(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).
12. Advanced Organic Chemistry- Carey and Sundberg Part B 5th Ed.

Course Code: CHO5402
Course Title: Advanced Synthetic Organic Chemistry
(4 credits)

Objectives:

1. To study the use of Transition metals in Organic synthesis and highlighting their importance in crucial organic conversions.
2. To study coupling reactions of Pd, Ni, Co, Fe Metals.
3. Involving recent method for preparation of C-C multiple bond.
4. Introducing modern multicomponent reactions for short synthesis.
5. To study Ring formation and Ring closing reaction.
6. Introduction to Click chemistry and metathesis which are recent methodologies in organic reaction.
7. Additional involvement of Boron and Silicon chemistry along with other important reaction.

Unit I	Transition metal complexes in organic synthesis ; only Pd, Ni, Co, Fe (Metal mediated C-C and C-X bond formation reactions: Suzuki, Heck, Sonogashira, Stille, Fukuyama, Kumada, Hiyama, Negishi, Buchwald-Hartwig, Noyori, Reppe, Oxo process	**(20 L)**
Unit II	C=C formation reactions: Wittig, Horner-Wordworth-Emmons, Shapiro, Bamford-Stevens, McMurry, Julia-Lythgoe and Peterson olefination reactions, Titanium-carbene mediated olefination: Tebbe, Petasis and Nysted reagent	**(8 L)**
Unit III	Multi-component reactions: Ugi, Passerini, Biginelli and Mannich reactions	**(5 L)**
Unit IV	Ring formation reactions: Pausan-Khand, Bergman and Nazerov cyclization	**(6 L)**
Unit V	Metathesis: Grubbs 1st and 2nd generation catalyst, Olefin cross coupling (OCM), ring closing (RCM) and ring opening (ROM) metathesis, applications	**(6 L)**
Unit VI	Use of Boron and Silicon in organic synthesis	**(10 L)**
Unit VII	Other important reactions: Baylis Hilman, Eschenmoser-Tanabe fragmentation, Mitsunobu reaction	**(5 L)**

References:

1. Organic synthesis using transition metals-Roderick Bates (Wiley)
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 – Michael 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, 5th edition (2007)
8. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken
9. Organic synthesis- Robert E Ireland
10. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barba

Course Code: CHO5403
Course Title: Asymmetric Synthesis
(4 Credits)

Objectives:

1. To understand principles of Asymmetric synthesis.
2. Applications of asymmetric syntheses in various synthetic methodologies.

Unit I	Recapitulation of Stereochemical concepts- enantiomers, diastereomers, homotopic and heterotopic ligands, stereoselective and stereospecific reactions, prochirality, Chemo-, regio-, diastereo- and enantio-controlled approaches	**(6 L)**
Unit II	Chirality transfer, Asymmetric inductions; Chiral pools, Chiral auxiliaries, chiral reagents and catalysts	**(10 L)**
Unit III	Organo-Catalysis	**(13 L)**
Unit IV	Asymmetric Reactions: Asymmetric oxidations: Sharpless asymmetric epoxidation, dihydroxylation, aminohydroxylation, Reduction reactions: Reduction of ketones, imines and olefins Asymmetric C-C bond forming reaction: Simmon-Smith reaction, Aldol reaction and alkylation based on Evans method, Mukayama aldol reaction, Shibasaki bi-metallic catalyst system; Meyers oxazoline; Michael reaction, Henry reaction (Nitro aldol), Baylis-Hillman-Morita reactions, Asymmetric allylation, Asymmetric hydroformylation.	**(15 L)**
Unit V	Stereoselective addition of nucleophiles to carbonyl group: Re-Si face concepts, Cram's rule, Felkin Anh rule, Houk model, Cram's chelate model.	**(12 L)**
Unit VI	Enzyme catalyzed reactions binding mechanism of enzymes	**(4 L)**

References:

1. Organic chemistry - J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
2. Advanced organic chemistry, Part B - F. A Carey and R. J. Sundberg, 5th edition (2007)
3. Asymmetric Reactions and Processes in Chemistry: Ernest L. Eliel
4. Catalytic Asymmetric Synthesis: 2nd Ed., Iwao Ojima
5. Asymmetric Organocatalysis: From Biomimetic Concept to Applications in Asymmetric Synthesis: David MacMillan
6. Asymetric synthesis Vol.1-5 by J. D. Morrison
7. Principles and Applications of Asymmetric Synthesis, Guo-Qiang Lin, Yue-Ming Li and Albert S. C. Chan, Wiley
8. Advanced Asymmetric Synthesis, Stephenson, George Richard, Springer

Elective Course

Course Code: CHO5404
Course Title: Carbohydrate as Chirons in Chiral Drugs Synthesis
(2 credits)

Objectives:

1. To understand chiral nature of sugars and their use as Chiron in syntheses of various chiral molecules.
2. To understand importance of chiral drugs and syntheses of few chiral drug molecules.
3. To understand various drug targets and structure activity relationship between drug molecules and their targets.

Unit I	**Carbohydrates** Introduction of sugars, structures of triose, tetrose, pentose, hexose, stereochemistry and reactions of Glucose, conformation and anomeric effects in hexoses Ref. 1, 2	**(6 L)**
Unit II	**Chiron approach** a) Introduction b) The concept of chiral templates and chirons wherein the carbon skeleton is the chiral precursor, Utilization of the basic concepts for retrosynthetic strategy and synthesis of the – (S) Propanediol, (R) and (S) – Epichlorohydrin, L (+)-Alanine, 9(-) Multistratin, (-) Pentenomycin, (-) Shikimic acid, Ref. 1,2,3	**(10 L)**
Unit III	**Chiral Drugs:** a) Introduction of chiral drugs, Eutomer, Distomer and eudesmic ratio. b) Distomers: a) with no side effects b) with undesirable side effects Synthesis and pharmacological activity of S-Ibuprofen, S-Metaprolol, Ininvir sulfate, Dextropropoxyphen, (+)Ephedrine, Griseofulvin, R-Indacrinnone, hydrochloride, Scaptopril Ref. 4, 5	**(14 L)**

References:

1. Organic Chemistry – R. P. Morrison and R. N. Boyd
2. Organic Chemistry – I. L. Finar, volume II
3. Chiron Approach in organic synthesis – S. Hanessianh
4. Pharmaceutical Chemistry and drug synthesis –Rot and Kleeman
5. Drug Design –E.J. Arienes

Course Code: CHO5408
Course Title: Medicinal Chemistry
(2 credits)

Objectives:

1. To study history of medicinal chemistry.
2. To study antimicrobial, antiviral, antibacterial, antifungal, antiprotozoals , antimalarials and ant amoebic drugs.
3. To understand principles of Medicinal Chemistry in various fields of drug research.

Unit I	Introduction to drugs, their action and discovery Ref. 1, 2, 3	**(4 L)**
Unit II	Relation of Drug structure and its chemical and biological properties Ref. 1, 2, 3	**(4 L)**
	Structure, activity and quantitative relationship Ref. 1, 2, 3	**(4 L)**
	Drug targets Ref. 3	**(6 L)**
	Antimicrobial drugs: a) Antibactaerials: Discovery and development of Penicillins, Cephalosporins, Sulphones and sulphonamides, Tetracyclins, Macrolides, Polypeptides, Chloromycetin b) Antifungals: Fungal Diseases and Anti-fungal agents c) Antivirals: Viral diseases and Anti-viral drugs d) Anti-protozoals: Anti-malarials, Anti-amoebic Ref. 4, 5, 6	**(12 L)**

References:

1. Medicinal Chemistry an Introduction-Gareth Thomas 2nd Ed. Wiley
2. An introduction to medicinal chemistry-Graham L. Patrick 5th Ed. Oxford
3. Introduction to Medicinal Chemistry-Alex Gringauz (Wiley)
4. Foye's Medicinal Chemistry
5. Medicinal Chemistry-A. Burger
6. Medicinal Chemistry-Ashutosh Karr

Course Code: CHO5409
Course Title: Agrochemicals
(2 credits)

Objectives:

1. To understand various types of agrochemicals and their classification.

Unit I	**Manures:** Humus and decomposing organic matter in soils, Compost and composting of agriculture and city wastes, Manures, Oil cakes, Role of Micro-organisms in the process. Types and Chemical properties of Manures. Application of Organic Manures and Soil fertility and Vermi-culture, Vermi-composting, Enriched Vermi-culture. **B)** a.	**(10 L)**
Unit II	**Fertilizers:** a. **Nitrogenous fertilizers**: Ammonium nitrate, Urea, Calcium Cyanamide, Calcium Ammonium Nitrate, Sodium Nitrate, Ammonium Chloride: Introduction, Raw materials, Manufacture, Action of as a fertilizers b. **Phosphate fertilizers:** Normal super phosphate, Triple Super Phosphate, Ammonium Phosphate. Potassic fertilizers, Bricakating technology of fertilizers, Mixed fertilizers and positions of Fertilizer Industries in India. c. **Biofertilizers:** d. Nitrogen fixation by Azetobacter, Acetobacter, Phosphate Solubilizing Bacteria, Algal culture, Production and Quality assessment. **e. Plant Growth promoters and hormones** Gibberellins, b) Auxins, c) Cytokinins, d) Ethylene **f. Applications of agrochemicals**	**(20 L)**

References:

1. Buchel, K. H. 1983 Chemistry of pesticides. John Wiley and Sons New York.
2. Collings G. H. 1955 Commercial Fertilizers. Mc Graw Hill Publishing Co. New York.
3. Geroge W. W 1986. Fundamentals of pesticides A self-instruction Guide. Thomas publication P.O. Box 9335. Frenocalifornia.
4. Sree Ramulu, U. S. 1979. Chemistry of Insecticides and Fungicides. Oxford and IBH Publishing House Co. New Delhi.

Course Code: CHO5405
Course Title: Organic Chemistry Practical Course VII
(4 Credits)

Green Chemistry and Chemical Biology Experiments (Any Eleven)

1. Preparation of acetanilide from aniline and acetic acid using Zn dust
2. Base catalyzed aldol condensation using $LiOH.H_2O$ as a Catalyst. Bromination of *trans*-stilbene using sodium bromide and sodium bromate
3. Bromination of *trans*-stilbene
4. [4+2] cycloaddition reaction in aqueous medium at room temperature
5. Benzil Benzilic acid rearrangement under solvent free condition
6. Thiamine hydrochloride catalyzed synthesis of benzoin from benzaldehyde
7. Clay catalyzed solid state synthesis of 7-hydroxy-4-methylcoumarin
8. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate
9. Bromination of acetanilide using ceric ammonium nitrate in aqueous medium
10. Green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst
11. Nitration of phenol
12. Preparation of 1,1-*bis*-2-naphthol under grinding at room temperature.
13. Synthesis of adipic acid
14. Synthesis of dihydropyrimidinone
15. Synthesis of biodiesel
16. Preparation of ionic liquid, [pmlm]Br
17. Preparation of 2- phenylbenzothiazoles catalyzed by ionic liquid, [pmlm]Br

Course Code: CHO5406
Course Title: Organic Chemistry Practical Course VIII
(4 Credits)

Projects / Agrochemicals and Polymer Industry Oriented Experiments (Any Fifteen)

A. Synthesis of Pesticides / Analogs: (Any Eleven)

1. Phenyl Urea.
2. 1-Naphthoxy acetic acid.
3. Dimethyl phthalate.
4. Maleic / Phthalyl hydrazide.
5. 2-Chlorophenoxy acetic acid.
6. Benzoyl glycine.
7. 4-Chlorophenoxy acetic acid.
8. Phenyl benzoate.
9. Acetanilide.
10. *p*-Bromoacetanilide.
11. *p*-Bromoaniline.
12. Benzanilide.
13. *N*,*N*-Diphenyl benzanilide .
14. Phthalimide
15. *N*,*N*-Dimethylaniline- 4-Formyl-*N*,*N*-dimethylaniline
16. 4-methylacetanilide from *p*-toludine
17. Emulsion Polymerization of Styrene
18. Preparation of Polyester by Condensation Polymerization

B. Isolation of Natural Products (Any Four)

1. Caffeine from tea leaves (Soxhlet extraction)
2. Piperine from pepper (Soxhlet extraction)
3. Eucalyptus oil from leaves (Steam distillation)
4. Lycopene from tomatoes
5. Trimyristin from nutmeg
6. Cinnamaldehyde from cinnamom
7. Eugenol from clove

References:

1. A Textbook of Practical Organic Chemistry - A. I. Vogel - ELBS with Longman, 5th Ed., (1989)
2. Laboratory Manual of Organic Chemistry - R. K. Bansal - Wiley Eastern 3rd Ed., (1994)
3. Advanced Practical Organic Chemistry - N. K. Vishnoi - Vikas 2nd Ed., (1996)

Course Code: CHO5407
Course Title: Self-Learning Course - 4
(1 Credit)

Objectives:

1. To explore involvement of chemistry in every aspect of life

Chemistry in Everyday Life:

Students are expected to select one topic and do necessary research regarding it and submit report of the study completed, few suggested areas for selection of such topics are listed below

1. Chemistry and waste management
2. Chemistry and pollution
3. Chemistry in food industry
4. Chemistry involved in signaling in nature
5. Forensic science