

M.Sc. CHEMISTRY

**ORGANIC CHEMISTRY SPECIALISATION
SYLLABUS OF III & IV SEMESTERS
*REVISED AS PER NEW (CB) SYLLABUS***

**FOR STUDENTS ADMITTED FROM THE YEAR
2016 ONWARDS**

M.Sc. CHEMISTRY (ORGANIC CHEMISTRY SPECIALISATION)

Syllabus for III and IV Semesters

(for the batches admitted in academic year 2016 & later under CBCS pattern)

[Under Restructured CBCS Scheme]

Grand total marks and credits (all 4 semesters) 2400 marks – 96 credits

(Approved in the P.G.BOS meeting held on 01-07-2017)

SEMESTER-III

Paper	Instruction Hrs/Week	Internal assessment marks*	Semester marks	Total marks	Total credits
CH(OC)301T	4	20	80	100	4
CH(OC)302T	4	20	80	100	4
CH(OC)303T	4	20	80	100	4
CH(OC)304T	4	20	80	100	4
CH(OC)351P	9	-	100	100	4
CH(OC)352P	9	-	100	100	4
Total				600	24

SEMESTER - IV

Paper	Instruction Hrs/Week	Internal assessment marks*	Semester marks	Total marks	Total credits
CH(OC)401T	4	20	80	100	4
CH(OC)402T	4	20	80	100	4
CH(OC)403T	4	20	80	100	4
CH(OC)404T	4	20	80	100	4
CH(OC)451P	9	-	100	100	4
CH(OC)452P	9	-	100	100	4
Total				600	24

* 15 marks for the written test and 5 marks for the assignment

Grand total all 4 semesters: 2400 marks and 96 credits

[Under Restructured CBCS Scheme]

III SEMESTER SYLLABUS	IV SEMESTER SYLLABUS
<p>Paper-I CH (OC) 301T: Synthetic Reagents, Advanced NMR, Conformational Analysis and ORD OC-09: Synthetic Reagents-I OC-10: Synthetic Reagents-II OC-11: ¹³C NMR and 2D NMR spectroscopy OC-12: Conformational analysis (Cyclic systems) and ORD</p> <p>Paper II- CH (OC) 302T: Modern Organic Synthesis OC-13: Asymmetric synthesis OC-14: Synthetic strategies OC-15: New Synthetic reactions OC-16: New techniques and concepts in organic synthesis</p> <p>Elective-3A Paper-III CH (OC) 303T (CB1): Bioorganic Chemistry OC(CB1)-1: Carbohydrates OC(CB1)-2: Nucleic acids and Lipids OC(CB1)-3: Proteins and Enzymes OC(CB1)-4: Coenzymes and Vitamins</p> <p>Elective-3B: Paper-III CH (OC) 303T (CB2): Forensic Chemistry and Toxicology OC(CB2)-5: Forensic chemistry- I OC(CB2)-6: Forensic chemistry- II OC(CB2)-7: Forensic Toxicology-I OC(CB2)-8: Forensic Toxicology-II</p> <p>Elective-4A Paper-IV CH (OC) 304T (CB3): Green chemistry and Organic materials OC (CB3) - 9: Principles of Green chemistry OC (CB3) -10: Green Synthesis OC (CB3) -11: Organic nanomaterials OC (CB3) -12: Supramolecular chemistry</p> <p>Elective-4B Paper-IV CH (OC) 304T (CB4): Pesticides OC (CB4) - 13: Introduction to pesticides OC (CB4) - 14: Synthetic insecticides OC (CB4) - 15: Natural insecticides & herbicides OC (CB4) - 16: Fungicides, and Rodenticides</p> <p>LABORATORY COURSES Paper-V CH (OC) 351P: Synthesis of organic molecules, isolation of natural products & TLC. Paper-VI CH (OC) 352P: Separation and identification of organic compounds & Column chromatography</p>	<p>Paper-I CH (OC) 401T: Drug Design and Drug Discovery OC-17: Principles of Drug design and drug discovery OC-18: Lead modification and SAR Studies OC 19: QSAR studies and computer aided drug design OC 20: Combinatorial Synthesis</p> <p>Paper-II CH (OC) 402T: Drug synthesis and mechanism of action OC-21: Drugs acting on metabolic process, cell wall and specific enzymes OC-22: Drugs acting on genetic material and immune system OC-23: Drugs acting on receptors and ion channels OC-24: Chiral drugs</p> <p>Elective-3A Paper-III CH (OC)-403T (CB1): Advanced Heterocyclic Chemistry OC (CB1) 17: Non aromatic heterocyclics & aromaticity OC (CB1) 18: Five and six membered heterocyclics with two hetero atoms OC (CB1) 19: Heterocyclics with more than two hetero atoms OC (CB1) 20: Larger ring and other heterocycles</p> <p>Elective-3B Paper-III CH (OC)-403T (CB2): Polymers, dyes and Pigments OC (CB2) 21: Polymers- I OC (CB2) 22: Polymers- II OC (CB2) 23: Dyes-I OC (CB2) 24: Dyes-II and pigments</p> <p>Elective-4A (ID Paper) Paper-IV CH (OC) 404(CB3)T: Advanced Natural Products OC(CB3)-25: Biosynthesis of natural products OC(CB3)-26: Structure determination of natural products -I OC(CB3)-27: Structure determination of natural products-II OC(CB3)-28: Total stereo selective synthesis of natural products.</p> <p>Elective-4B (ID Paper) Paper-IV CH (OC) 404 (CB4) T: Biopharmaceutics and Pharmacodynamics OC(CB4)-29: Pharmacokinetics OC(CB4)-30: Pharmacodynamics OC(CB4)-31: Principles of Therapeutics OC(CB4)-32: Drug Interactions</p> <p>LABORATORY COURSES Paper-V CH (OC) 451P: Spectroscopic identification of organic compounds & practice of chemistry software programmes Paper-VI CH (OC) 452P: Synthesis and analysis of drugs</p>

**M.Sc. ORGANIC CHEMISTRY SPECIALISATION
 III SEMESTER SYLLABUS**

(For the batch admitted during the academic year 2016-2017)

Paper-1CH (OC) 301T: Synthetic Reagents, Advanced NMR, Conformational Analysis and ORD

OC-09: Synthetic Reagents-I

OC-10: Synthetic Reagents-II

OC-11: ^{13}C NMR and 2D NMR spectroscopy

OC-12: Conformational analysis (Cyclic systems) & ORD

Paper II– CH (OC) 302T: Modern Organic Synthesis

OC-13: Asymmetric synthesis

OC-14: Synthetic strategies

OC-15- New Synthetic reactions

OC-16: New techniques and concepts in organic synthesis

Elective-3A Paper-III CH (OC)303T (CB1): Bioorganic Chemistry

OC(CB1)-1: Carbohydrates

OC(CB1)-2: Nucleic acids and Lipids

OC(CB1)-3: Proteins and Enzymes

OC(CB1)-4: Coenzymes and Vitamins

Elective-3B: Paper-III CH (OC) 303T (CB2): Forensic Chemistry and Toxicology

OC(CB2)-5: Forensic chemistry- I

OC(CB2)-6: Forensic chemistry- II

OC(CB2)-7: Forensic Toxicology-I

OC(CB2)-8: Forensic Toxicology-II

Elective-4A Paper-IV CH (OC) 304T (CB3): Green chemistry and Organic materials

OC (CB3) - 9: Principles of Green chemistry

OC (CB3) -10: Green Synthesis

OC (CB3) -11: Organic nanomaterials

OC (CB3) -12: Supramolecular chemistry

Elective-4B Paper-IV CH (OC) 304T (CB4): Pesticides

OC (CB4) - 13: Introduction to pesticides

OC (CB4) - 14: Synthetic insecticides

OC (CB4) - 15: Natural insecticides & herbicides

OC (CB4) - 16: Fungicides, and Rodenticides

Laboratory courses:

Paper-V CH (OC) 351P: Synthesis of organic molecules, isolation of natural products and TLC.

Paper-VI CH (OC) 352P: Separation and identification of organic compounds & Column chromatography.

**M.Sc. CHEMISTRY (ORGANIC CHEMISTRY)
III SEMESTER SYLLABUS**

(For the batch admitted during the academic year 2016 -2017 under the CBCS pattern)

Paper-1CH (OC) 301T: Synthetic Reagents, Advanced NMR, Conformational Analysis and ORD

OC-09: Synthetic Reagents-I

OC-10: Synthetic Reagents-II

OC-11: ^{13}C NMR and 2D NMR spectroscopy

OC-12: Conformational analysis (Cyclic systems) & ORD

OC-09: Synthetic Reagents I

15 Hrs

i) Protecting groups: a) Protection of alcohols by ether, silyl ether and ester formation
b) Protection of 1,2-diols by acetal, ketal and carbonate formation
c) Protection of amines by benzyloxycarbonyl, t-butyloxycarbonyl, fmoc and triphenyl methyl groups.
d) Protection of carbonyls by acetal, ketal and thiol acetal (Umpolung) groups.
e) Protection of carboxylic acids by ester and ortho ester (OBO) formation.

ii) Organometallic Reagents: Preparation and application of the following in organic synthesis: 1) Organolithium 2) Organo copper reagents 3) Organoboranes in C-C bond formation 4) Organo silicon reagents: reactions involving β -carbocations and α -carbanions, utility of trimethyl silyl halides, cyanides and triflates.

iii) Carbonyl methylenation: a) Phosphorous ylide mediated olefination 1) Wittig reaction, 2) Horner-Wordsworth-Emmons reaction. b) Titanium- Carbene mediated olefination 1) Tebbe reagent, 2) Petasis reagent 3) Nysted reagent.

iv) Carbene insertions: Rh based carbene complexes, cyclopropanations.

v) C-H Activation: Introduction, Rh catalysed C-H activation.

OC-10: Synthetic Reagents II

15 Hrs

i) Oxidations: a) Oxidation of active C-H functions: DDQ and SeO_2 . b) Alkenes to diols: Prevost and Woodward oxidation
c) Alcohol to carbonyls: Cr^{VI} oxidants (Jones reagent, PCC, PDC) IBX, DMP, CAN, TEMPO, TPAP, Swern oxidation
d) Oxidative cleavage of 1,2-diols: Periodic acid and Lead tetra acetate.

ii) Reductions: a) Catalytic hydrogenation: Homogenous (Wilkinson's catalytic hydrogenation) and heterogeneous catalytic reduction. b) Non-metallic reductions: Diimide reduction
c) Dissolving metal reductions: Birch reduction. d) Nucleophilic metal hydrides: LiAlH_4 , NaBH_4 , and their modifications. e) Electrophilic metal hydrides: BH_3 , AlH_3 and DIBAL. f) Use of tri-n-butyl tin hydride: Radical reductions.

OC-11: ^{13}C NMR and 2D NMR spectroscopy 15 Hrs

i) ^{13}C NMR spectroscopy: Introduction, Types of ^{13}C nmr spectra: undecoupled, proton-

decoupled and off-resonance decoupled (ORD) spectra. ^{13}C chemical shifts, factors affecting the chemical shifts, chemical shifts of organic compounds. Calculation of chemical shifts of alkanes, alkenes and alkynes. Homonuclear (^{13}C , ^{13}C J) and heteronuclear (^{13}C , ^1H J and ^{13}C , ^2H J) coupling. Applications of ^{13}C -NMR spectroscopy: Structure determination, stereochemistry, reaction mechanisms and dynamic processes in organic molecules. ^{13}C -NMR spectral editing techniques: principle and applications of APT, INEPT and DEPT methods.

ii) 2D-NMR spectroscopy: Principles of 2D NMR, Classification of 2D-experiments. Correlation spectroscopy (COSY) HOMOCOSY (^1H - ^1H COSY), TOCSY (Total Correlation Spectroscopy), HeteroCOSY (^1H , ^{13}C COSY, HMQC), long range ^1H , ^{13}C COSY (HMBC), Homonuclear and Heteronuclear 2D-J-resolved spectroscopy, NOESY and 2D-INADEQUATE experiments and their applications.

OC-12: Conformational analysis (Cyclic systems) & ORD 15 Hrs

Conformational analysis (Cyclic systems)

Study of conformations of cyclohexane, mono, di and tri substituted cyclohexanes, (1,3,5-trimethyl cyclohexanes and Menthols), cyclohexanone (2-alkyl and 3-alkyl ketone effect), 2-halocyclohexanones, cycloheptane. Stereo chemistry of bicyclo[3,3,0]octanes, hydrindanes, decalins and perhydroanthracenes. Conformational structures of piperidine, N-Methylpiperidine, tropane, tropine, pseudotropine, decahydroquinoline and quinolizidine. Factors governing the reactivity of axial and equatorial substituents in cyclohexanes.

(oxidation, $\text{S}_{\text{N}}2$ reaction, rearrangements, Ester hydrolysis) Stereochemistry of addition to the carbonyl group of a rigid cyclohexanone ring.

Optical Rotatory Dispersion (ORD) and CD Spectroscopy: Optical rotation, circular birefringence, circular dichroism and Cotton effect. Plain curves and anomalous curves. Empirical and semiempirical rules-The axial haloketone rule, the octant rule, Helicity rule, Exciton chirality method. Application of the rules to the study of absolute configuration and conformations of organic molecules.

Recommended Books:

1. Some modern methods of organic synthesis by W. Carruthers
2. Guidebook to organic synthesis, by R K Meckie, D M Smith & R A Atken
3. Organic Synthesis by O House
4. Organic synthesis by Micheal B Smith
5. Reagents for organic synthesis, by Fieser & Fieser, Vol 1-11 (1984)
6. Organic synthesis by Robert E Ireland
7. Handbooks of reagents for organic synthesis by Reich and Rigby, Vol I-IV
8. Organic chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren
9. Organic Reactions and their mechanisms by P.S. Kalsi
10. Organic reaction mechanisms by V.K. Ahulwalia and Rakesh Kumar Parashar
11. Spectroscopic identification of organic compounds by RM Silverstein, G C Bassler and T B Morrill
12. Organic Spectroscopy by William Kemp
13. Spectroscopic methods in Organic chemistry by DH Williams and I Fleming
14. Modern NMR techniques for chemistry research by Andrew B Derome

15. NMR in chemistry - A multinuclear introduction by William Kemp
16. Spectroscopic identification of organic compounds by P S Kalsi
17. Introduction to organic spectroscopy by Pavia
18. Carbon-13 NMR for organic chemists by GC Levy and O L Nelson
19. Nuclear Magnetic Resonance Basic principles by Atta-ur-Rahman
20. Basic one and two-dimensional NMR spectroscopy by Horst Friebolin
21. NMR spectroscopy by H.Gunther
22. Stereochemistry of organic compounds — Principles & Applications by D Nasipuri
23. Stereochemistry of Carbon compounds by Ernest L Eliel & Samuel H. Wilen
24. Stereochemistry: Conformation & Mechanism by P S Kalsi
25. The third dimension in organic chemistry, by Alan Bassendale
26. Stereo selectivity in organic synthesis by R S Ward.
27. Advanced organic chemistry. Part A Structure & Mechanism by Francis A. Corey and Richard J. Sundberg
28. Optical rotatory dispersion by C Djerassi
29. Optical rotatory dispersion and circular dichroism by P Crabbe
30. Mechanism and Structure in Organic chemistry by S Mukherjee

Paper II– CH (OC) 302T:Modern Organic Synthesis

OC-13: Asymmetric synthesis

OC-14: Synthetic strategies

OC-15: New Synthetic reactions

OC-16: New techniques and concepts in organic synthesis

OC-13:- Asymmetric synthesis 15 Hrs

Introduction: Brief revision of classification of stereo selective reactions

Prostereoisomerism: Topicity in molecules Homotopic, stereoheterotopic (enantiotopic and diastereotopic) groups and faces- symmetry criteria.

Prochiral nomenclature: Pro chirality and Pro-R, Pro-S, Re and Si.

Conditions for stereoselectivity: Symmetry and transition state criteria, kinetic and thermodynamic control. Methods of inducing enantioselectivity.

Analytical methods: % Enantiomeric excess and diastereomeric ratio. Determination of enantiomeric excess: specific rotation, Chiral NMR; Chiral derivatizing agents, Chiral solvent, Chiral shift reagents and Chiral HPLC.

Chiral Substrate controlled asymmetric synthesis: Nucleophilic additions to chiral carbonyl compounds. 1, 2- asymmetric induction, Cram's rule and Felkin-Anh model.

Chiral auxiliary controlled asymmetric synthesis: α -Alkylation of chiral enolates, Evans's oxazolidinone, 1, 4-Asymmetric induction and Prelog's rule..

Chiral reagent controlled asymmetric synthesis: Asymmetric reductions using BINAL-H. Asymmetric hydroboration using IPC_2BH and IPC_2BH_2 .

Chiral catalyst controlled asymmetric synthesis: Sharpless epoxidation. Asymmetric hydrogenations using chiral Wilkinson biphosphine catalyst.

Asymmetric aldol reaction: Diastereoselective aldol reaction (achiral enolate & achiral aldehydes) its explanation by Zimmerman-Traxel model.

OC-14: Synthetic Strategies 15 Hrs

Introduction: Terminology, Target, synthon, synthetic equivalent, functional group interconversion (FGI), functional group addition. Criteria for selection of target. Linear and convergent synthesis. Retrosynthetic analysis and synthesis involving chemoselectivity, regioselectivity, reversal of polarity and cyclizations. .

Order of events: S-Salbutamol, Propoxycaïne..

One group C-C and C-X disconnections: Introduction .One group C-C disconnections in alcohols and carbonyl compounds. One group C-X disconnections in Carbonyl compounds, alcohols, ethers and sulphides.

Two group C-C and C-X disconnections : Introduction .Two group C-X disconnections in 1,1-difunctionalised, 1,2-difunctionalised and 1,3-difunctionalised compounds.

Two group C-C disconnections: Diels-Alder reaction, 1,3-difunctionalised compounds, 1,5-difunctionalised compounds, Michael addition and Robinson annulation.

Control in carbonyl condensations: oxanamide and mevalonic acid.

Strategic bond: definition, guidelines for disconnection; disconnection of C-X bonds, disconnect to greatest simplification, using symmetry in disconnection, disconnection corresponding to known reliable reaction, high yielding steps and recognizable starting materials. Retrosynthesis of Retronecine, longifoline.

OC-15: New Synthetic reactions

15 Hrs

- 1. Metal mediated C-C and C-X coupling reactions:** Suzuki, Heck, Stille, Sonogishira crosscoupling, Buchwald-Hartwig and Negishi-Kumada coupling reactions.
- 2. C=C Formation Reactions:** Shapiro, Bamford-Stevens, McMurrey reactions, Julia-Lythgoe olefination and Peterson's stereoselective olefination.
- 3. Multicomponent Reactions:** Ugi, Passerini, Biginelli, Bergman and Mannich reactions.
- 4. Ring Formation Reactions:** Pausan-Khand reaction, Nazarov cyclisation.
- 5. Click Chemistry:** Click reaction, 1,3-dipolar cycloadditions.
- 6. Metathesis:** Grubb's 1st and 2nd generation catalyst, Olefin cross coupling metathesis (OCM), ring closing metathesis (RCM), ring opening metathesis (ROM), applications.
- 7. Other important synthetic reactions:** Baylis-Hilman reaction, Eschenmoser-Tanabe fragmentation, Mitsunobu reaction, Stork-enamine reaction and Michael reactions.

OC-16: New techniques and concepts in organic synthesis 15 Hrs

- 1. Techniques in peptide synthesis:** Solid phase peptide synthesis, commonly used resins (Rink resin, Wang resin and Ellman resin, synthesis of cross linked Merrifield resin and drawbacks of solid phase synthesis.
- 2. Solid phase oligodeoxynucleotide synthesis:** Phosphotriester, phosphitetriester and phosphoramidite pathway
- 3. Oligosaccharide synthesis:** Glycosidation: cyclic oxocarbenium ion, glycosyl donors and glycosyl acceptors, Kuhn glycosidation, convergent and linear oligosaccharide synthesis.
- 4. Phase Transfer catalysis:** Onium and crown ethers as PTC.
- 5. Tandem synthesis:** Tandem reactions; conjugate addition-aldol reaction, polymerization-cyclisation, electrocyclic-Diels Alder reaction.
- 6. Baldwin Rules:** Exo and Endo cyclisation, tetrahedral, trigonal and diagonal systems, favoured and disfavoured cyclisations.
- 7. Chiron approach in organic synthesis:** Nature's chiral pool, carbohydrates, amino acids, hydroxy acids, terpenes as chiral precursors. Synthesis of shikimic acid from D-arabinose, furanonycin from D-glucose, S-(-)-ipenol from S-leucine.
- 8) Determination of absolute configuration:** Mosher's method.

Recommended Books:

1. Asymmetric synthesis by Nogradi
2. Asymmetric organic reactions by J D Morrison and H S Mosher
3. Principles in Asymmetric synthesis by Robert E. Gawley & Jeffrey Aube
4. Stereo differentiating reactions by Izumi
5. Some modern methods of organic synthesis by W Carruthers
6. Guidebook to organic synthesis, by R K Meckie, D M Smith & R A Atken
7. Organic synthesis by Michael B Smith
8. Organic Synthesis-The disconnection approach by S Warren
9. Organic Synthesis by C Willis and M Willis
10. Problems on organic synthesis by Stuart Warren
11. Organic chemistry Jonathan Clayden, Nick Greeves and Stuart Warren
12. The logic of chemical synthesis by Elias James Corey and Xue-Min Cheng
13. Name reactions by Jie-Jie Li

Elective-3A

Paper-III CH (OC)303T (CB1): Bioorganic Chemistry

- OC(CB1)-1: Carbohydrates**
OC(CB1)-2: Nucleic acids and Lipids
OC(CB1)-3: Proteins and Enzymes
OC(CB1)-4: Coenzymes and Vitamins

OC(CB1)-1: Carbohydrates **15 Hrs**
 Introduction to the importance of Carbohydrates. Types of naturally occurring sugars. Deoxy sugars, aminosugars, branched chain sugars methyl ethers and acid derivatives of sugars. Determination of configuration and determination of ring size of D-glucose and D-Fructose. Conformational analysis of monosaccharides. 4C_1 and 1C_4 conformations of D-glucose. Reactions of six carbon sugars: Ferrier, Hanesian reaction and Ferrier rearrangement. Synthesis of amino, halo and thio sugars. Structure, ring size determination of sucrose and maltose. Conformational structures of sucrose, lactose, maltose, cellobiose and gentobiose. Structure and biological functions of starch, cellulose, glycogen and chitin. Role of sugars in cell to cell recognition, blood groups.

OC(CB1)-2: Nucleic acids & lipids **15 Hrs**
Nucleic acids: Retro synthetic analysis of nucleic acids - Nucleotides, Nucleosides, Nucleotide bases and Sugars. Structure and synthesis of nucleosides and nucleotides. Primary, secondary and tertiary structure of DNA. Types of mRNA, tRNA and rRNA. Replication, transcription and translation. Genetic code. Protein biosynthesis. DNA finger printing.
Lipids: Introduction and classification of lipids. Stereochemical notation in lipids. Chemical synthesis and biosynthesis of phospholipids and glycolipids. Properties of lipid aggregates, micelles, bilayers, liposomes and biological membranes.

OC(CB1)-3: Proteins and Enzymes **15 Hrs**
Proteins: Introduction. Peptide bond, classification and nomenclature of peptides. Amino acid sequence of polypeptides and proteins: terminal residue analysis and partial hydrolysis. Peptide synthesis by solution phase and solid phase synthesis methods. Proteins - Biological importance and classification - Primary, secondary and tertiary structure of proteins.
Enzymes: Definition. Classification based on mode of action. Mechanism of enzyme catalysis - Lock and Key, Induced-Fit and three point contact models. Enzyme selectivity - chemo, regio, diastereo and enantio selectivity - illustration with suitable examples. Factors affecting enzyme catalysis. Enzyme inhibition- reversible and irreversible inhibition. Enzymes in organic synthesis. Immobilised enzymes

OC(CB1)-4: Coenzymes and Vitamins **15 Hrs**
Coenzymes: Introduction. Co-factors - cosubstrates - prosthetic groups. Classification - Vitamin derived coenzymes and metabolite coenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate (PLP), oxidized and reduced forms of I) nicotinamide adenosine dinucleotide / their phosphates (NAD), NADH, NADP⁺ NADPH) ii) Flavin adenine nucleotide FAD, FADH₂ and iii) Flavin mononucleotide (FMN, FMNH₂) lipoic acid, biotin, tetrahydrofolate and ubiquinone. Adenosine triphosphate (ATP) and adenosine diphosphate (ADP), S-adenosyl

methionine (SAM) and uridine diphosphosugars (UDP-sugars) Mechanism of reactions catalyzed by the above coenzymes.

Vitamins: Introduction, classification and biological importance of vitamins. Structure determination and synthesis of vitamins A, B₁, and B₂. Synthesis of vitamins - B₆, C, E and K. Structure of vitamin B₁₂.

Reference Books:

1. Organic Chemistry Vol.I and Vol.II by I.L.Finar
2. Carbohydrate Chemistry by Barton Volumes
3. Carbohydrate chemistry by G.J.Boons
4. The chemistry of natural products:vol.V - carbohydrates by S.F.Dyke
5. Organic Chemistry by McMurry
6. Nucleic acids in Chemistry and Biology by G M Blackburn MI Gait
7. LehningerPrinciples of Biochemistry by D L Nelson and M MCoxon
8. Outlines of Biochemistry by Conn and Stumpf
9. Enzyme structure and mechanism by Fersht and Freeman
10. Enzymes for green organic synthesis by V.K.Ahluwalia
11. Biotransformations in Organic Chemistry by K Faber.
12. Principles of biochemistry by Horton &others.
13. Bioorganic chemistry - A chemical approach to enzyme action by Herman Dugasand Christopher Penney.
14. Concepts in Biotechnology by D.Balasubramanian& others
15. Chemistry and physiology of the vitamins by H.R.Rosenberg.

Paper-III CH (OC)303T (CB2): Forensic Chemistry & Toxicology

OC(CB2)-5: Forensic chemistry- I

OC(CB2)-6: Forensic chemistry- II

OC(CB2)-7: Forensic Toxicology-I

OC(CB2)-8: Forensic Toxicology-II

OC(CB2)-5: Forensic chemistry-I

15 Hrs

Forensic Chemistry - Introduction - Types of cases / exhibits - Preliminary screening - presumptive tests (colour and spot tests) - Examinations procedures involving standard methods and instrumental techniques

Qualitative and quantitative forensic analysis of inorganic and organic material - Chemical fertilizers (N,P,K) - Insecticides (Endosulfan, Malathion, Carbaryl) - Metallurgical analysis (Fe, Cu, Zn, Au, Ag) - Natural products (tobacco, tea, sugars, rubber) - Industrial chemicals - Sulphuric, Nitric and Hydrochloric acids, Sodium, Potassium hydroxide, Ammonium nitrate, Potassium chlorate, Organic solvents like Methanol, Ethanol, Acetone, Chloroform and Ether Organic chemicals like Acetanilide, P- Aminophenol, and Nitrobenzene etc. with reference to forensic work.

OC(CB2)-6: Forensic chemistry-II

15 Hrs

Examination of petroleum products - Distillation and fractionation - various fractions and their commercial uses - Standard method of analysis of petroleum products - Analysis of petroleum products for adulteration and arson residues. Chemistry of fire - Investigation and evaluation of fires - Causes of fire - Analysis of arson residues by conventional and instrumental methods. Analysis of trace evidence - Cosmetics, Dyes, Trap related evidence materials, Paints, Pigments, Fibres, Oils fats, Greases, Industrial dusts, Chemicals and Plant materials.

OC(CB2)-7: Forensic Toxicology-I 15 Hrs

Toxicology- Introduction- History- Scope- Areas of Toxicology- Role of forensic toxicologist- Poisons- Classification of poisons- Types of poisoning- Sample collection and preservation of toxicological exhibits in fatal and survival cases- Storage of samples- Signs and symptoms of poisoning- Toxicological investigation/examination of poisoned death- Interpretation of toxicological data- Courtroom testimony in toxicological cases. Case Histories.

OC(CB2)-8: Forensic Toxicology-II

15 Hrs

Principles of Toxicology- Introduction - Pharmacokinetics - Methods of transportation of toxicant- Absorption- Distribution- Storage of toxicants- Redistribution - Metabolism- Oxidation

- Reduction - Hydrolysis - Conjugation - Excretion- Other routes of elimination-Toxicokinetics- one and two compartmental model - Toxicodynamics- Spectrum of undesired (toxic) effects- Interaction of chemicals- Tolerance- Dose response relationship- Developmental and reproductive toxicity- Mutagenicity- Toxicity testing.

Recommended books:

1. James, S. H. and Nordby, J. J.: Forensic Science: An Introduction to Scientific and Investigative Techniques, 2003.
2. Saferstein, R: Criminalistics - An Introduction to Forensic Science, Prentice Hall, 1995.
3. Sarkar, S: Fuels and Combustion, Orient Longman, 1990
4. Verma, R. M: Analytical Chemistry – Theory and Practice, CBS Pub., 1994
5. Svehla, G. Ed.: Vogel's Qualitative Inorganic Analysis, Longman, 1998.
6. Bassett: Vogel's Text Book of Quantitative Inorganic Analysis, Longman, 1978
7. Vogel, A. I: Text Book of Practical Organic Chemistry including Qualitative Organic Analysis, ELBS, 1971.
8. Narayanan, T. V: Modern Techniques of Bomb Detection and Disposal, R. A. Security System, 1995.
9. Almirall, J. R. and Furton, K. G: Analysis and Interpretation of Fire Scene Evidence, CRC Press, 2004.
10. Bogusz, M. J: Handbook of Analytical Separations : Vol. 2 ,Forensic Science, Elsevier, 2000.
11. Bureau of Indian Standards: Specifications and Methods of Analysis for Petroleum Products.
12. Wilson and Wilson's Comprehensive Analytical Chemistry Volumes
13. Standard Methods of Chemical Analysis
14. AOAC: Official Methods of Analysis
15. Daeid, N.N.: Fire Investigation: Theory and Practice, Taylor and Francis, 2003
16. Klaassen, C. D.,: Casarett and Doull's Toxicology: The Basic Science of Poisons, 5th ed, McGraw-Hill, 1995.
17. Moffat, A.C. : Osselton, D. M. Widdop, B. : Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, body fluids and postmortem material, 3rd ed., Pharmaceutical Press 2004.
18. Bogusz, M. J.,: Hand Book of Analytical Separations, Vol. 2: Forensic Science, 1st ed., Elsevier Science ,2000.
19. Siegel, J.A., Saukko, P. J., Knupfer, G.,: Encyclopedia of Forensic Sciences (Vol3), Academic Press, 2000.
20. Paranjape, H.M., Bothara, G.K., Jain, M.M.: Fundamentals of Pharmacology, 1st ed., Nirali Prakashan, 1990.
21. Budhiraja, R.D.: Elementary Pharmacology and Toxicology, Popular Prakashan, 2nd ed., 1999.
22. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005
23. Cravey, R.H; Baselt, R.C.: Introduction to Forensic Toxicology , Biochemical Publications, Davis, C.A. (1981)
24. Stolmen, A.; Progress in Chemical Toxicology: Academic Press, New York (1963)
25. Modi, Jaisingh, P.; Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Publication (2001)
26. Eckert; An Introduction to Forensic Science, CRC Press

Elective-4A

Paper-IV CH (OC) 304T (CB3): Green chemistry and Organic materials

OC (CB3) -9: Principles of Green chemistry

OC (CB3) -10: Green Synthesis

OC (CB3) -11: Organic nanomaterials

OC (CB3) -12: Supramolecular chemistry

OC (CB3)-9: Principles of Green Chemistry

15 Hrs

Green chemistry: Introduction

Principles of Green Chemistry: Designing a Green Synthesis using these principles; Prevention of Waste/by-products; maximum incorporation of the starting materials used in the synthesis into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals; selection of appropriate auxiliary substances - green solvents, ionic liquids and solvent-free synthesis: energy requirements for reactions - use of microwaves, ultrasonic energy in organic synthesis; prevention of unnecessary derivatization – careful use of protecting groups; use of catalytic reagents in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

OC (CB3) -10: Green Synthesis

15Hrs

i) Microwave Assisted Organic Synthesis (MAOS): introduction, benefits and limitations

a) Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Claisen rearrangement and Diels- Alder reaction.

b) Microwave assisted Solvent-free reactions: Deacetylation, saponification of esters, alkylation of reactive methylene compounds and synthesis of nitriles from aldehydes.

ii) Ultrasound Assisted Organic Synthesis: introduction, applications of ultrasound- Cannizzaro reaction, Reformatsky reaction and Strecker synthesis.

iii) Organic Synthesis in Green Solvents: introduction

a) Aqueous Phase Reactions: Diels-Alder Reaction, Heck reaction, Hoffmann elimination, Claisen-Schmidt condensation hydrolysis and dihydroxylation reactions.

b) Organic Synthesis using Ionic liquids: Introduction, applications- Beckmann rearrangement Suzuki Cross-Coupling Reaction and Diels- Alder reaction.

iv) Green Catalysts in organic synthesis: introduction

a) Phase Transfer Catalysts in Organic Synthesis: Introduction, Williamson ether synthesis and Wittig reaction

b) Biocatalysts in Organic Synthesis: Biochemical (microbial) oxidations and reductions.

OC (CB3) -11: Organic Nanomaterials

15Hrs

Introduction: The 'top-down' approach, the 'bottom-up' approach and Nanomanipulation.

Molecular Devices: Photochemical devices, Liquid crystals, Molecular wires, Rectifiers, Molecular switches and Molecular Muscles.

New Carbon family: Types of Fullerenes, Types of Carbon nanotubes (Zig-Zag, Armchair and Chiral), Graphenes. Growth, Chemical Synthesis and optoelectronic properties of Fullerenes, CNTs (Zig Zag, Armchair and Chiral), singlewalled CNTs (SWCNTs) and multi walled MWCNTs) and Graphenes.

Structures of aromatics belts, nano car and molecular machines.

Optoelectronic molecules: OLEDs, Organic Solar Cells (Basic OLED mechanism and structures)

Natural Benzheterazoles and their synthetic modifications as optoelectronic molecules.

OC (CB3) -12: Supramolecular Chemistry

15Hrs

Introduction: Supramolecular interactions (ion-ion, ion-dipole, H-bonding, cation- π , anion- π , π - π and Van der Waals interactions), Ionophore and molecular receptors.

Host-Guest Chemistry: Lock and key analogy, Structures and applications of Cryptands, Spherands, Calixerenes, Cyclodextrins, Cyclophanes, Carcerands and hemicarcerands.

Self-assembly: Ladder, polygons, helices, rotaxanes, catenanes, Molecular necklace, dendrimers, self-assembly capsules their synthesis, properties and applications.

Enantioselective molecular recognition: Cyclodextrins, Crown ethers with chiral frame work, Chiral receptor from Kemp's triacid. Chiral receptors for tartaric acid.

Recommended books:

1. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
2. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker, (2001).
3. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
4. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).
5. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalya Publishers
6. Enantioselective organocatalysis, Peter I Dalloc, Willey-VCH
7. Core Concepts in Supramolecular Chemistry and Nanochemistry by Jonathan W. Steed, David R. Turner and Karl J. Wallace; John-Wiley and Sons Publications
9. Supramolecular Chemistry by Jonathan W. Steed and Jerry L. Atwood, John-Wiley and Sons Publications
10. Supramolecular Chemistry-Concepts and Perspectives by J M. Lehn; Willey-VCH (1995) Publications
11. Supramolecular Chemistry by P. D. Beer, P. A. Gale and D. K. Smith; Oxford University Press (1999)
12. Stereochemistry of organic compounds -Principles & Applications by D Nasipuri
13. Nanochemistry by G.B. Sergeev; Elsevier
14. Nanochemistry: A chemical approach to nano materials , G.A. Ozin & A.C. Arsenault; RSC publishers.

Elective-4B

Paper-IV CH (OC) 304T (CB4): Pesticides

OC(CB4)- 13:Introduction to pesticides

OC(CB4)- 14: Synthetic insecticides

OC(CB4)- 15:Natural insecticides& herbicides

OC(CB4)- 16:Fungicides, and Rodenticides

OC (CB4)-13: Introduction to pesticides

15 Hrs

i) **Defination** ,Classification and importance of pesticides

ii) **Pest control**: Different methods –chemical – insecticides, fungicides, herbicides, rodenticides, fumigants, chitin synthesis inhibitors and insect repellents.

a) **Biological**–pheromones: Definition and classification, synthesis of Disparlure, Exobrevicomin, Endobrevicomin, frontalin and grandiso pheromones, synthetic sex attractants.

b) Insect juvenile hormones: JH-A, JH-B,Synthesis of juvabione. Structural formula and importance of methopren.

c) Moultingharmones-structural formulae and mode of action of ecdysones

d) Antibiotics and secondary metabolites of microbial origin as insecticides and fungicides in agricultiure. Structural formula and importance of Blastocidin-S, Kasugamycin, Avermectin-B, Invermectin, piercidins and phytoalexins.

iii) **Environmental pollution from pesticides**.iv) Integrated pest management.

v) Pesticide formulations: Dusts, Granules, Wettable powders, Emmulsions and Aerosols.

OC (CB4)- 14: Synthetic insecticides

15 Hrs

i)**Organochlorine insecticides**- synthesis and mode of action of methoxychlor, perthan, Dicofol, Heptachlor, Dieldrin and Endosulfan.

ii) **Organophosphorous insecticides** –synthesis and mode action of Phosphoric acid derivatives, phosdrin, Dichlorophos, parathion, Zolone, Aninphomethyl, TEPP and Sachradan.

iii) **Carbamate insecticides**- synthesis and mode of action of carbamyl, Furadan, Baygon, Aldicarb and Zectron.

iv) Formulation and residue analysis of organochlorine, organophosphorous and carbamate insecticides.

OC (CB4)- 15: Natural insecticidesand herbicides15 Hrs

i) **Insecticides of palnt origin** –synthesis and importance of pyrethrins (I and II), Rotenone and Nicotine. Main constituents Neem-structural formula of Azadirachtin. Synthesis of polygodial and warbunganol(Antifeedants).

ii)Synthesis of pyrethroids: synthesis of Allethrin, Bioallethrin, Cypermethrin, Fenvalerate, Decemethrin and pyriethrelone.

iii) **Concept of Bioinsecticides** – Bacillus thuringiensis.

iv) **Concept of pro-insecticides**-structure and mode of action of pro-pheromones and pre-pro-insecticides.

v) **Herbicides** – synthesis,applications and mode of action of the following

a)Aryloxyalkyl carboxylic acid derivative:2,4-D, MCPA,2,4,5-T and 2,4,5-TP.b) Carbamates-propham and chloropham, c)Urea derivatives –Monouron and diuron, d) Aliphatic acids-Dalapon,TCA, e)Aromatic acids -2,3,6-TBA,Dicomba and Amiben, f)Nitrogen heterocyclic dericvatives –Simazine,Atrazine,Amitrole,Maleic hydrazide Diquat and paraquat, g) Phenols-PCP and Dinoseb, h) Benzonitrile compounds

OC (CB4)-16: Fungicides, and Rodenticides**15 Hrs****i) Fungicides** –classification, synthesis, application and mode of action of the following classes:**a)** Carbamates **b)** Quinones-chloranil, Dichlorodimethyl p-aminobenzene **c)** perchloromethylmercaptan derivative –captan, folpet, Difolatan and Mesulfan **d)** Benzimidazoles-carbendazim, Benomyl and Thiabendazole**ii) Rodenticides**, a) Anticoagulants-synthesis and application of warfarin, Coumatetralyl, Dicoumarol and Bromodiolen. **b)** Acute poisons- application of pindone, Ratindan, Sodium Fluoroacetate, Barium fluoroacetate, Antu, Tetramine, pindone and castrix.**Reference books:**

- 1) Naturally occurring insecticides: M. Jacobson and D.G. Crosby.
- 2) Insecticides for future: Jacobson
- 3) Insect juvenile hormone chemistry and action : J.J Mann and M. Beroza
- 4) Polygodial and warburganal. Terpenoid antifeedants part-II rec, Tran, chin 106
- 5) Insect antifeedants : S.V. Iley & P.L. Toogood, chemistry in Britain, Jan 1990 P.31
- 6) Synthesis of Insecticides : Metcalf
- 7) Fungicides-Freear
- 8) Fungicides-Nene
- 9) Residue reviews vol.36 : Melnikov
- 10) Safer insecticides : E. Hodgson
- 11) Crop protection agents from Nature: Leonard G Copping
- 12) Biofertilizers and Bioinsecticides : A.M. Deshmukh
- 13) Insecticides and Fungicides : U. Sriramulu.
- 14) Organo chlorine insecticides : persistent organic pollutants : F. Moriarty
- 15) Herbicides : P.C. Kearney & D.D. Kaufman
- 16) Analytical Method for pesticides : Z. Weig (Vol III)
- 17) Pesticide formulations : Van Valkenburg
- 18) Insecticides : A.S. Tahori
- 19) Herbicides, fungicides, formulation chemistry - A.S. Tahori
- 20) Environmental pollution by pesticides : C.A. Edwards
- 21) Pesticides management and insecticide resistance : Watson and Brown
- 22) Organo phosphorous pesticides M. eto

Laboratory courses:

Paper CH (O) 351P: Synthesis of organic molecules, isolation of natural products & TLC

(A) Laboratory synthesis of the following compounds:

2-Phenyl indole (Fischer indole synthesis), 7-hydroxy-3-methyl flavone (Baker-Venkatraman reaction), 2,5-Dihydroxy acetophenone (Fries reaction), 4- Chlorotoluene from p-toluidine (Sandmeyer reaction), Benzilic acid from benzoin (Benzilic acid rearrangement), Benzpinacol (photochemical reaction), 7-hydroxy coumarin (Pechman synthesis), Photo-dimerization of maleic anhydride, benzophenone (Friedel-Crafts reaction), Benzanilide (Beckmann rearrangement), Vanillyl alcohol from vanillin (NaBH₄ reduction), 2- and 4-nitrophenols (nitration and separation by steam distillation), Acridone from Phthalic anhydride.

(B) Isolation of the following natural products:

Caffeine from tea leaves (solvent extraction), Piperine from pepper (Soxhlet extraction), Eucalyptus oil from leaves (steam distillation), Lycopene from tomatoes.

(C) Thin layer chromatography : Thin layer chromatography: Determination of purity(All the above preparations) , monitoring the progress of chemical reactions (any of the four above preparations), identification of unknown organic compounds by comparing the R_f values of known standards.

Paper CH (O) 352P: Separation and identification of organic compounds & Column chromatography

Separation of two component mixtures by chemical methods and their identification by chemical reactions — separation by using solvent ether, 5 % aqueous sodium bicarbonate, 5% sodium hydroxide and dil hydrochloric acid, checking the purity of the two components by TLC, identification of the compounds by a systematic study of the physical characteristics (mp/bp), extra elements (nitrogen, halogens and sulfur), solubility, functional groups, preparation of crystalline derivatives and identification by referring to literature. A minimum of **09** mixtures should be separated and analyzed by these procedures.

Cannizzaro reaction: 4-Chloro benzaldehyde as substrate and separation of the resulting two component mixture

Separation of three component mixtures by chemical methods. A minimum of two mixtures should be separated and analyzed.

Column chromatography: Separation of a mixture of *ortho* and *para*-nitroanilines and any one of the two component mixture using silica gel as adsorbent and chloroform as the eluent. The column chromatography should be monitored by TLC.

Recommended Books:

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

M.Sc. ORGANIC CHEMISTRY SPECIALISATION
IV SEMESTER SYLLABUS
(For the batch admitted during the academic year 2016-2017)

Paper-1 CH (OC) 401T: Drug Design and Drug Discovery

- OC-17: Principles of Drug design and drug discovery
- OC-18: Lead modification and SAR Studies
- OC 19: QSAR studies and computer aided drug design
- OC-20: Combinatorial Synthesis

Paper-II CH (OC) 402T: Drug synthesis and mechanism of action

- OC-21: Drugs acting on metabolic process, cell wall and specific enzymes
- OC-22: Drugs acting on genetic material and immune system
- OC-23: Drugs acting on receptors and ion channels
- OC-24: Chiral drugs

Elective-3A Paper-III CH (OC)-403T (CB1): Advanced Heterocyclic Chemistry

- OC (CB1) 17: Non aromatic heterocyclics & aromaticity
- OC (CB1) 18: Five and six membered heterocyclics with two hetero atoms
- OC (CB1) 19: Heterocyclics with more than two hetero atoms
- OC (CB1) 20: Larger ring and other heterocycles

Elective-3B Paper-III CH (OC)-403T (CB2): Polymers, dyes and Pigments

- OC (CB2) 21: Polymers- I
- OC (CB2) 22: Polymers- II
- OC (CB2) 23: Dyes-I
- OC (CB2) 24: Dyes-II and pigments

Elective-4A Paper-IV CH (OC) 404(CB3)T: Advanced Natural Products

- OC(CB3)-25: Biosynthesis of natural products
- OC(CB3)-26: Structure determination of natural products -I
- OC(CB3)-27: Structure determination of natural products-II
- OC(CB3)--28: Total stereo selective synthesis of natural products.

Elective-4B Paper-IV CH (OC) 404(CB4)T: Biopharmaceutics and Pharmacodynamics

- OC(CB4)-29 : Pharmacokinetics
- OC(CB4)-30 : Pharmacodynamics
- OC(CB4)-31 : Principles of Therapeutics
- OC(CB4)-32: Drug Interactions

Laboratory courses

- Paper-VCH (OC) 451P:** Spectroscopic identification of organic compounds & practice of chemistry software programmes
- Paper-VI CH (OC) 452P:** Synthesis and analysis of drugs

M.Sc. CHEMISTRY (ORGANIC CHEMISTRY)
IV SEMESTER SYLLABUS
(For the batch admitted during the academic year 2016 -2017 under the CBCS pattern)

Paper-1 CH(OC) 401T: Drug Design and Drug Discovery

OC-17: Principles of Drug design and drug discovery
OC-18: Lead modification and SAR Studies
OC 19: QSAR studies and computer aided drug design
OC 20: Combinatorial Synthesis

OC- 17: Principles of Drug design and drug discovery **15 Hrs**

Introduction to drug discovery. Folklore drugs, stages involved in drug discovery- disease, drug targets, bioassay. Discovery of a lead- screening of natural products and synthetic compound libraries. Existing drugs as leads (me too drugs). Pharmacokinetics (ADME), pharmacodynamics. Nature of drug – receptor interactions and their theories – Occupancy theory, Induced – fit theory, Macromolecular perturbation theory and Two-state model of receptor activation. Natural products as lead structures in drug discovery – Pharmacophore - structure pruning technique e.g. morphine. Discovery of lead structure from natural hormones and neurotransmitters. Principles of design of agonists (e.g. Salbutamol), antagonists e.g. cimitidine) and enzyme inhibitors (e.g. captopril). Drug discovery without lead – serendipity- Penicillin and Librium as examples. Principles of prodrug design. Introduction to drug patents and Clinical trials.

OC-18: Lead modification and SAR Studies **15 Hrs**

SAR: Lead modification strategies, Bioisosterism, variation of alkyl substituents, chain homologation and branching, variation of aromatic substituents, extension of structure, ring expansion and ring contraction, ring variation, variation and position of hetero atoms, ring fusion, simplification of the lead, rigidification of lead. Discovery of oxaminquine, salbutamol, cimitidine and captopril Structure-Activity Relationship studies in sulfa drugs, benzodiazepines, and taxol analogs.

OC-19: QSAR studies and computer aided drug design **15Hrs**

QSAR: Introduction, physicochemical properties - pKa, electronic effects and Hammett constants (σ), lipophilicity constant (π), steric effects and Taft's constant, linear and nonlinear relationship between biological activity Lipophilicity Substituent constants. Lipinski rule of five. Hansch analysis, Craig's plot, Topliss scheme, Free Wilson approach, cluster significant analysis. Two case studies (QSAR study on pyranenamine and design of Crizotinib).

Computer aided drug design: Introduction, active site, allosteric binding site, use of grids in docking, rigid docking, flexible docking and induced fit docking of ligands. Basic principles and difference between structure and ligand based drug design, denovo drug design and utility to optimize the lead structure.

OC-20: Combinatorial Synthesis**15Hrs**

Introduction. Combinatorial approach. Combinatorial libraries, technologies. Solid phase synthesis, types of resins. Linkers. Reactants for solid phased synthesis. Methods of Parallel synthesis: Haughton's tea bag procedure. Automated parallel synthesis. Methods in Mixed combinatorial synthesis: general principles. Furkas mix and split combinatorial synthesis, Structure determination of active compounds-Deconvolution, Methods in deconvolution-recursive deconvolution, tagging and use of decoded sheets. Examples of Combinatorial Chemistry. Planning and designing of combinatorial synthesis, Spider like scaffolds, drug molecules. Automation in Combinatorial chemistry. High throughput screening.

Reference books

1. Burger's medicinal chemistry and drug discovery by Manfred E. Wolf.
2. Introduction to Medicinal chemistry by Patrick.
3. Introduction to drug design by R Silverman
4. Comprehensive medicinal chemistry. Vol 1-5 by Hanzsch.
5. Principles of medicinal chemistry. by William Foye
6. Biochemical approach to medicinal chemistry. by Thomas Nogrady.
7. Pharmaceutical Chemistry and Drug synthesis by Roth and Kleeman
8. Drug design by E.J.Arienes
9. Principles of Medicinal Chemistty Vol I & II by Kadam et al
10. Medicinal chemistry An introduction by Garreth Thomas
11. Organic and Pharmaceutical chemistry By Delgrado
12. Organic Pharmaceutical chemistry By Harikishansingh
13. Medicinal Chemistry By Ashtoshkar
14. Medicinal Chemistry By Chatwal
15. Organic Drug synthesis By Ledneicer Vol 1-6
16. Strategies for organic drug synthesis and design By Daniel Ledneicer.
17. Top Drugs: Top synthetic routes By John Saunders
18. Chirotechnoiogy By Roger A. Sheldon
19. Burger's Medicinal Chemistry and Drug Discovery: Principles and Practices. Vol. 1.
20. Medicinal Chemistry by G. Patricks.
21. Text book of Drug Design and Discovery, Edited by PovlKrogsgaard – Larsen Tommy Liljefors.
22. Structure Based Drug Design of Crizotinib (PF-02341066), a Potent and Selective Dual Inhibitor of Mesenchymal–Epithelial Transition Factor (c-MET) Kinase and Anaplastic Lymphoma Kinase (ALK) Martin P. Edwards, J. Med. Chem., 2011, 54 (18), pp 6342–6363.
http://www.pfizer.com/news/featured_stories/featured_stories_martin_edwards.jsp

Paper-II CH (OC) 402T: Drug synthesis and mechanism of action

OC-21: Drugs acting on metabolic process, cell wall and specific enzymes

OC-22: Drugs acting on genetic material and immune system

OC-23: Drugs acting on receptors and ion channels

OC-24: Chiral drugs

OC-21: Drugs acting on metabolic process, cell wall and specific enzymes

Basic concepts of mechanism of drug action: Introduction to macromolecular targets, carbohydrates, proteins, lipids and nucleic acids as possible drug targets. Classification of drugs. Enzyme inhibition and its types.

a) Drugs acting on metabolic process:

Antifolates –Discovery and mechanism of action of sulphonamides, Synthesis of sulfomethoxazole, sulfadoxine, sulfaguanidine and dapsone.

Diaminopyrimidines -trimethoprim, bacterial resistance to sulfonamides and drug synergism

b)Drugs acting on cell wall: Structure of bacterial cell wall, β -Lactam antibiotics – mechanism of action of penicillins and cephalosporins. Synthesis of penicillin-G and cephalosporin-C, cefalexin and cycloserine. Resistance to penicillins, broad spectrum penicillins – cloxacillin, methicillin, ampicillin, amoxicillin and carbenicillin. β -Lactamase inhibitors- Structural formulae and mode of action of clavulanic acid and sulbactam

c)Drugs acting on specific enzymes: H^+/K^+ -ATPase inhibitors- synthesis of Omeprazole and Carbonic anhydrase inhibitors-synthesis of Acetazolamide.

OC-22: Drugs acting on genetic material and immune system

Drugs acting on genetic material:Introduction, classification and mechanism of action.

a) DNA-intercalating agents-Anticancer and antimalarial agents. Structural formulae of Daunomycin, Adriamycin and Amsacrine. Synthesis of Amsacrine, Nitracrine, Quinacrine and Chloroquine.

b) DNA- Binding and nicking agents: Antiprotozoal drugs. Synthesis of Metronidazole, Dimetridazole and Tinidazole.

c) DNA-Alkylators: Synthesis of Cyclophosphamide and Bisulphan.

d) DNA-Polymerase inhibitors: Antiviral agents- Synthesis of Acyclovir and AZT.

e) DNA-Topoisomerase inhibitors: Anti bacterial agents.Synthesis of Ciprofloxacin and Norfloxacin. Structural formulae ofloxacin and Lomefloxacin.

f) Inhibitors of transcribing enzymes: Anti-TB and antileprosy agents-structural formulae of Rifamycins and partial synthesis of Rifampicin.

g) Drugs interfering with translation process: Antibacterial drugs- Structural formulae of Erythromycin, 5-Oxytetracycline and Streptomycin. Synthesis of Chloromycetin

Drugs acting on immune system: Introduction to immune system. Immunosuppressing agent-structural formula of Cyclosporin. Immunoenhancers-use of vaccines and structural formula of levamisole.

OC-23: Drugs acting on receptors and ion channels

Introduction to nervous system: structure of neuron, nerve transmission. Definition and examples of agonist, antagonist, neurotransmitters and receptors.

Drugs acting on receptors:

a)Adrenergic receptors - Introduction and classification. α -Adrenergic-receptor agonists and antagonists- Synthesis and biological activity of Nor-adrenaline, Methyl L dopa and Tetrazosin.

β -Adrenergic-receptor - agonists and antagonists – Synthesis and pharmacological activity of Salbutamol, Tetrabotalin, Propranolol and Atenolol.

b)Cholinergic-receptors: Introduction and classification.Cholinergic-receptor agonists and antagonists- Structural formulae of Nicotine, Atropine and Tubocurarine. Synthesis of Acetyl choline and Succinyl choline

c)Dopamine receptors: Introduction and classification.Dopamine- receptoragonists and antagonists- Biosynthesis of Dopamine. Synthesis of L-Dopa and Chlorpromazine.

d)Serotonin receptors: Introduction and classification.Serotonin receptoragonists and antagonists-synthesis and pharmacological activity of Serotonin and Metoclopramide.

e)Histamine receptors:Introduction and classification.Histamine receptor agonists and antagonists-synthesis and biological action of Histamine, Chloropheneramine, and Ranitidine.

f) Hormones and their receptors: Introduction to estrogen receptors, Structural formulae of Tamoxifen

Drugs acting on ion channels: Introduction to ion channels, drugs acting on Ca^{2+} , Na^+ and Cl^- channels and their mode of action. Structural formulae of Tetracaine and synthesis and of Nifedipine, Diltiazem, Tetracaine and 4-Aminopyridine.

OC-24: Chiral drugs

Introduction to chiral drugs. Three-point contact model, Eutomer, Distomer and eudesmic ratio. Pfeiffer's rule. Role of chirality on biological activity: Distomers – a) with no side effects b)with undesirable side effects c) both isomers having independent therapeutic value d)combination products having therapeutic advantages e) metabolic chirality inversion.

Synthesis and pharmacological activity of S-Ibuprofen, S- Metoprolol, Ininavir sulfate, Levocetrazine, 2S-Verapamil, S,S-Ethambutol, (+)Lomefloxacin, Fluvastatin, Dextropropoxyphen, (+)Ephedrine, (+)Griseofulvin, Dexormaplatin, R-Indacrinone, Nateglinide, Oxybutynin hydrochloride, S,S- Captopril and S,S,S- Enalaprilate.

Reference Books:

1. Burger's medicinal chemistry and drug discovery. By Manfred B. Wolf.
2. Introduction to Medicinal chemistry. By Graham Patrick.
3. Introduction to drug design. By R.B.Silverman
4. Comprehensive medicinal chemistry. Vol 1-5 by Hanzsch.
5. Principles of medicinal chemistry. By William O. Foyeetal.
6. Biochemical approach to medicinal chemistry. By Thomas Nogrady.
7. Pharmaceutical Chemistry and Drug synthesis By Roth and Kleeman
8. Drug design By E.J. Arienes
9. Principles of Medicinal Chemistry. Vols.1 & 2 By Kadam etal
10. Medicinal chemistry An introduction By Gareth Thomas
11. Wilson and Gisvold,s text book of Organic, Medicinal and Pharmaceutical chemistry By J.N.Delgado and W.A.Remers.
12. Organic Pharmaceutical chemistry By Harikishansingh.
13. Medicinal Chemistry By Ashutoshkar
14. Medicinal Chemistry By G.Chatwal
15. Organic Drug synthesis By Ledneiser Vol 1-6
16. Strategies for organic drug synthesis and design By Daniel Ledneiser
17. Top Drugs: Top synthetic routes By John Saunders
18. Chirotechnology By Roger A. Sheldon

Elective-3A

Paper-III CH (OC)-403T (CB1): Advanced Heterocyclic Chemistry

OC (CB1) 17: Non aromatic heterocyclics & aromaticity

OC (CB1) 18: Five and six membered heterocyclics with two hetero atoms

OC (CB1) 19: Heterocyclics with more than two hetero atoms

OC (CB1) 20: Larger ring and other heterocycles

OC (CB1) 17: Nonaromatic heterocyclics & Aromaticity 15 Hrs

Different types of strains, interactions and conformational aspects of nonaromatic heterocycles. Synthesis, reactivity and importance of the following ring systems. Azirines, Aziridines, Oxiranes, Thiiranes, Diazirenes, Diaziridines, Oxaziridines, Azetidines, Oxetanes and thietanes

Aromaticity: Introduction, Aromatic and anti aromatic compounds. Criteria for aromaticity. Huckel's $4n+2$ electron rule for benzene and non benzenoid aromatic compounds. Eg. Cyclopropenium ion, cyclopentadienyl ion, cycloheptatrienium ion, azulene and annulenes.

OC (CB1) 18: Five and six membered heterocyclics with two hetero atoms 15 Hrs

Synthesis, reactivity, aromatic character and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Isoxazole, Isothiazole, Pyridazine, Pyrimidine. Pyrazine, Oxazine, thiazine, benzimidazole, benzoxazole and benzthiazole.

OC (CB1) 19: Heterocyclics with more than two hetero atoms 15 Hrs

Synthesis, reactivity, aromatic character and importance of the following Heterocycles: 1,2,3-triazoles, 1,2,4-triazoles, Tetrazoles, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,5-oxadiazole, 1,2,3-thiadiazoles, 1,3,4-thiadiazoles, 1,2,5-thiadiazoles, 1,2,3-triazine, 1,2,4-triazine, 1,3,5-triazine, tetrazines. Synthesis and importance of purines and pteridines. Synthesis of Caffeine, theobromine and theophylline.

OC (CB1) 20: Larger ring and other Heterocycles 15 Hrs

Synthesis, structure, stability and reactivity of Azepines, Oxepines and Thiopines. Synthesis of Diazepines rearrangements of 1,2-diazepines. Synthesis of Benzoazepines, Benzodiazepines, Benzooxepines, Benzothiepinines, Azocines and Azonines. Synthesis of selenophenes, Tellerophenes, Phospholes and Boroles.

Recommended Books:

1. Heterocyclic Chemistry, T. Gilchrist
2. An introduction to the Chemistry of heterocyclic compounds, R.M. Acheson
3. Heterocyclic Chemistry, J.A. Joule & K. Mills
4. Principles of Modern Heterocyclic Chemistry, A. Paquette
5. Heterocyclic Chemistry, J.A. Joule & Smith
6. Handbook of Heterocyclic Chemistry, A.R. Katritzky
7. The aromaticity III level, units 17-19 British open university volumes
8. Aromatic character and aromaticity by G.M. Badger
9. Non-benzenoid aromatic compounds by D. Ginsberg
10. Nonbenzenoid compounds by Lloy

Elective-3B

Paper-III CH (OC)-403T (CB2): Organic Polymers, Dyes and Pigments

OC (CB2) 21: Polymers- I

OC (CB2) 22: Polymers- II

OC (CB2) 23: Dyes-I

OC (CB2) 24: Dyes-II and pigments

OC (CB2) 21: Organic Polymers - 115 Hrs

Introduction, Classification of Polymers – according to origin, structure, intermolecular interactions. Types of polymerization – addition, condensation, radical, ionic and copolymerization with mechanism, Ziegler-Natta polymerization with mechanism. Stereochemistry of polymers, Plasticity – types of plastics. Molecular mass of polymers. Resins and plastics – Polystyrene and styrene copolymers, poly(vinyl chloride/vinyl acetate) and related polymers, acrylic polymers, polyesters, phenol-formaldehyde polymers, polyurethanes and epoxide polymers with examples. Natural and synthetic rubbers.

OC (CB2) 22: Organic Polymers - II

15 Hrs

a) Functional polymers :

i) Electrically conducting polymers: Introduction, basic principles. Brief description of polyanilines, polypyrroles, polyacetylenes, polythiophenes and their applications.

ii) Photoconductive polymers: Liquid crystal polymers, smectic, nematic and cholesteric structures, ion-exchange polymers – cationic, anionic exchange polymers and their uses.

iii) Smart materials: Uses in sensing device and communication networks.

iv) Biodegradable polymers: Definition, classification. Brief description polyhydroxyalkanoates, polycaprolactones, polyactic, polyvinyl alcohol and their applications.

b) Membranes: Filtration, micro, ultra, nano filtration. Separation of gases-Permeability and gas permeability representative polymers. Liquid separation-dialysis, electroosmosis and reverse osmosis.

c) Fire retarding polymers and photonic polymers.

Polymers in biomedical application, artificial organs and controlled drug delivery.

OC (CB2) 23: Dyes – I

15 Hrs

Synthetic and Natural dyes

Introduction, nomenclature and classification of synthetic dyes. Color and constitution - chromophores and auxochromes with suitable examples, Witt's theory, Armstrong's theory, Baeyer's theory, Nietzki's theory, Waston's theory, Modern theories, Valence Bond Theory and Molecular orbital theory. Chemistry and synthesis of triphenyl methane dyes [malachite green, rosaniline, para aniline blue, crystal violet methyl violet, hydroxytriphenyl methane dyes, Aurin, chrome violet], Azo dyes - types of azo dyes, synthesis of acidic and basic azo dyes, mono azo, di azo, tri azo and poly azo dyes. Chemistry and synthesis of cyanine dyes. Natural dyes – structure determination and synthesis of alizarine, Quinazarin and Indigo.

OC (CB2) 24: Dyes-II and Pigments

15 Hrs

a) Introduction to Fluorescence dyes

Interaction of organic molecules with electromagnetic radiation. Energy diagram. Activation and deactivation of organic molecules by light. Fluorescence and delayed fluorescence. Effect of molecular structure on fluorescence. General properties of fluorescent dyes and their requirements. Triplet-triplet absorption of organic molecules. Fluorescent quantum

yields and factors affecting them. Synthesis of Fluorescent aromatic hydrocarbons. and Fluorescent heteroaromatic compounds.

b) **Introduction to laser dyes.** Synthesis of Oligophenylenes. Oxazoles and benzoxzoles. Stilbenoid compounds Coumarin laser dyes, Rhodamine laser dyes.

c) **Pigments:** Introduction, Structures of Porphyrins , Bile pigments. Synthesis of Haemin and Chlorophyll. Synthetic pigments – preparation of phthalocyanines.

Reference Books

1. Organic polymer chemistry by K.J.Sanders
2. Polymer syntheses, Vol.I by S.R.Sandler and W.Karo
3. The elements of Polymer Science and Engineering by A.Rudin
4. Principles of Polymer Chemistry by A.Ravve
5. Polymer Science by V.R.Gowariker , N.V.Viswanathan and J.Sreedhar
6. Polymer Chemistry by C.E.Carraher , Jr.
7. A text book of polymers, Vol. I,II,III, M.S. Bhatnagar , S. Chand
8. Polymer Chemistry, B. Vollmert
9. Textbook of Polymer Science, F. W. Billmeyer Jr, John Wiley & sons
10. Organic Chemistry , Vol.1,2 by I.L.Finar
11. Color and constitution of organic molecules by J.Griffiths
12. Functional Dyes, Elsevier BV 2006,,,,,,S H.KIM
13. Colorants for non-textile Applications, Elsevier BV 2000 ...H S Freeman and A T Peters
14. Industrial Dyes-Chemistry, Properties, Applications. WILEY-VCH Verlag, 2003
Klaus Hunger
15. Introduction to Fluorescence Sensing, Springer 2009, by A P Demchenko
16. Natural Dyes and their Applications in Textiles by M. L. Gulrajani, IIT Delhi
17. Handbook on Natural Dyes for Industrial Applications by P. S. Vankar, National Institute of Industrial Research
18. Stereoelectronic Effects in Organic Chemistry by Pierre Deslongchams, Pergamon Press
19. Chemistry and Biochemistry of plant pigments, Vol. 2, by T.W.Goodwin
20. Contemporary Polymer Chemistry, H. R. Alcock& F. W. Lambe, Prentice Hall
21. Materials science and engineering an introduction by William D Callister, Jr. Wiley Publishers

Elective-4A(ID Paper)

Paper-IVCH (OC) 404(CB3)T: Advanced Natural Products

OC(CB3)-25: Biosynthesis of natural products
OC(CB3)-26: Structure determination of natural products-I
OC(CB3)-27: Structure determination of natural products-II
OC(CB3)-28: Total stereo selective synthesis of natural products.

OC(CB3)-25: Biosynthesis of natural products 15 Hrs

Biosynthesis of secondary metabolites: Introduction, Difference between Laboratory synthesis and biosynthesis. Methods for determination of biosynthetic mechanism. Isolation and identification of Biosynthetic precursors, Feeding experiments – use of radioisotopes Measurement of incorporation – absolute incorporation, specific incorporation. Identification of the position of labels in labeled natural products by chemical degradation and spectral methods. Major biosynthetic pathways: 1) Acetate-Malonate pathway: Biosynthesis of aromatic compounds, 2) Shikimic acid pathway ; Biosynthesis of essential amino acids – phenylalanine, tyrosine and tryptophan, carboxylic acid derivatives, flavonoids and morphine alkaloids. 3) Mevalonic acid pathway : Biosynthesis of terpenes – mono, sesqui, di, tri (β -amyrin) and carotenoids, steroids – cholesterol.

OC(CB3)-26: Structure determination of natural products-I 15 Hrs

Determination of structure and stereochemistry of morphine, reserpine, abietic acid, cholesterol and rotenone.

OC(CB3)-27: Structure determination of natural products-II 15 Hrs

Spectroscopic techniques IR, UV, ^1H nmr, ^{13}C nmr, COSY, HETEROCOSY, NOESY, 2D-INADEQUATE and MS in the structure elucidations of natural products, Examples, flavones, biflavones, flavanones, isoflavones, coumarins, quinolines, isoquinolines.

Study of the following solved problems: Mass, IR, ^1H , ^{13}C NMR, HOMOCOSY, HECTOR, DEPT, 2D-INADEQUATE and NOE of Geraniol, INEPT of **menthol**, APT of **aparricine**,

Heteronuclear 2D-J resolved spectrum of **stricticine**, NOESY of **buxaquamarine**, HETEROCOSY of **strictanol**, 2D-INADEQUATE of **α -picoline** and **β -methyl tetrahydran furan**.

OC(CB3)-28: Total stereoselective synthesis of natural products. 15 Hrs

Nicalou's synthesis of Dynemicin A , Corey's synthesis of prostaglandins (E2, F2 α) and paeoriflorin, Sharpless synthesis of L-hexoses, Nicolaous synthesis of taxol, Danishefsky synthesis of indolizomycin, Takasago synthesis of menthol, Hoffmann-LaRoche synthesis of Biotin.

Reference books:

1. Textbook of organic chemistry, Vol II by I L Finar
2. Chemistry of natural products, Vol 12, by Atta-Ur-Rahman
3. An introduction to the chemistry of terpenoids and steroids, by William templeton
4. Systematic identification of flavonoid compounds by Mabry & Markham
5. Steroids by Fieser and Fieser
6. Alkaloids by Manske
7. Alkaloids by Bentley
8. The chemistry of terpenes by A Pinder
9. The terpenes by Simenson
10. Terpenoids by Mayo
11. Alkaloids by Pelletier
12. Total synthesis of Natural Products by Apsimon Vol 1-5
13. Biosynthesis by Geismann
14. Principles of organic synthesis 3rd Ed. R O C Norman and J M Coxen
15. One and two dimensional nmr spectroscopy by Atta Ur Rahman
16. Classics in total synthesis K C Nicolaou and E J Sorenson
17. Spectrometric identification of organic compounds by Silverstein and Webster

Elective-4B(ID Paper)

Paper-IV CH (OC) 404(CB4)T: Biopharmaceutics and Pharmacodynamics

OC(CB4)-29 : Pharmacokinetics

OC(CB4)-30 : Pharmacodynamics

OC(CB4)-31 : Principles of Therapeutics

OC(CB4)-32: Drug Interactions

OC(CB4)-29: Pharmacokinetics.

Introduction and importance of ADME studies of drugs. Routes of administration .
i)Absorption: Definition, absorption of drugs across the membranes. Physico chemical factors affecting the drug absorption (emphasis on pH partition hypothesis and Drug Dissolution). Methods of determination of drug absorption. Bioavailability. ii)Distribution: Apparent volume of drug distribution. Factors affecting distribution, plasma protein binding. iii) Metabolism: Sites of drug metabolism, metabolic rate constant, bioactivation and biotransformation of drugs (phase I and phase II reactions) iv)Elimination: Types of elimination and overall apparent elimination rate constant and half-life, concept of clearance.

OC(CB4)-29: Pharmacodynamics.

Introduction, targets for drug action, receptor concept. Pharmacological binding terms. Two-statereceptor model, receptor families- structure and signal transduction mechanisms- channel linked proteins, gating mechanism, G-protein coupled receptors, G-protein and their role, Targets for G-proteins, Kinase linked receptors, receptors that regulate gene transcription. Theories of concentration -response relationship, dose-response curves.

OC(CB4)-30: Principles of Therapeutics

Plasma Drug concentration vs Time profile, Definition and explanation of various terms: MEC, MSC, MTC, AUC(graph). Peak plasma concentration, time of peak concentration. Therapeutic range. Steady state concentration, onset of action, onset of time, duration of action, intensity of action. LD50, ED50. Therapeutic objective. Dosage regimen, Design of dosage regimes: Dose size, dosing frequency, drug accumulation during multiple dosing, time to reach steady-state during multiple dosing, average concentration and body content on multiple dosing to steady state, loading dose, maintenance dose, maintenance of drug within the therapeutic range, design of dosage regimen from plasma concentration. Kinetics of fixed dose, fixed time interval regimes. Modification to dosage regime: Dosing of drugs in obese patients, dosing of drugs in Neonates, infants & children, dosing of drugs in geriatrics (elderly), dosing of drugs in Hepatic disease, dosing of drugs in renal disease.

OC(CB4)-31: Drug Interactions.

Introduction, classification, Mechanisms of drug interactions.– pharmacokinetic interactions(alteration of gastrointestinal absorption, complexation and adsorption, alteration of distribution, alteration of metabolism and alteration of excretion) & pharmacodynamic interactions (antagonistic effects, synergistic effects, alteration of electrolyte levels, interactions involving adrenergic system, alteration of receptor site interaction and antibiotic combinations). Influence of alcohol(Anti biotics, Anti coagulants, Anti histamines, Anti psychotic drugs, sedatives and Hypnotics), smoking(Theophylline, Diazepam, a Tri cyclic antidepressants), food (Bronchodilators, Diuretics, ACE Inhibitors, Anti coagulants, Tetracyclines) on drug action.

Reference books:

1. Pharmacokinetics. By Shobha Rani
2. Elements of Pharmacology. By Gandhi, Desani & Goyal.
3. Goodman & Gilman's "The pharmacological basis of therapeutics. By Gilman & Rali.
4. Pharmacology. By Rang.
5. Biopharmaceutics and pharmacokinetics By Brahmanikar
6. Pharmacology By Lippincot
7. Modern Pharmacology with Clinical Applications. By R. Craig.
8. Comprehensive pharmacy review by Leon Shargel
9. Hospital and clinical pharmacy
10. Burger's medicinal chemistry and drug discovery. By Manfred E. Wolf.
11. Introduction to Medicinal chemistry. By Patrick.
12. Comprehensive medicinal chemistry. Vol 1-5 By Hanzsch.
13. Principles of medicinal chemistry. By William Foye
14. Biochemical approach to medicinal chemistry. By Thomas Nogrady.

Laboratory courses

Paper CH (OC) 451P: Spectroscopic identification of organic compounds & practice of chemistry software programmes

1. Identification of unknown organic compounds by interpretation of IR, UV, ^1H -NMR, ^{13}C NMR, and mass spectral data(two examples with 2D-NMR). A minimum of 30 representative examples should be studied.

2. Chemistry software programmes: Chem Draw, analysis of IR and NMR using ACD/Id NMR processor. EXCEL: Drawing graphs, Molecular docking.

Paper CH (OC) 452P: Synthesis and analysis of drugs

(A) Laboratory Synthesis of the following drugs:

Paracetamol, Phenytoin, Benzocaine, 6-Methyluracil, Chloritone, Fluorescein, 4-Aminobenzene sulfonamide, antipyrine and phenothiazine

(B) Estimation of the following drugs:

Aspirin (titrimetry), Ibuprofen (titrimetry), Analgin (titrimetry), Chloride in Ringer's lactate (argentometry), ascorbic acid {titrimetry, Iodometry and Cerimetry}, colorimetry}, Isoniazid(Iodometry), Riboflavin(colorimetry), Zn ions in Bactracin Zinc, Ca^{+2} ions in Calcium gluconate injection(complexometry), Riboflavin (UV-Visible Spectrophotometer).

Reference books:

1. Practical organic chemistry by Mann & Saunders
2. Text book of practical organic chemistry by Vogel
3. The systematic identification of organic compounds by Shriner et.al
4. Analytical chemistry by G N David Krupadanam et.al
5. Advanced practical medicinal chemistry by Ashutoshkar
6. Pharmaceutical drug analysis by Ashutoshkar
7. Quantitative analysis of drugs in pharmaceutical formulations by P D Sethi
8. Practical pharmaceutical chemistry part-1 and part-2 by A H Beckett and J B Stenlake
9. Spectroscopic identification of organic compounds by R M Silverstein and F X Webster