



Deccan Education Society's
Fergusson College (Autonomous)
Pune

Learning Outcomes-Based Curriculum
for 2 years M.Sc. Programme
as per guidelines of
NEP-2020

for
S. Y. M. Sc. (Organic Chemistry)

With effect from Academic Year
2023-2024

M. Sc. II Organic Chemistry

Course Structure

Semester	Paper Code	Paper Title	Credits
III	CHO-601	Stereochemistry of Organic Molecules	4
	CHO-602	Structure Determination by Analytical Methods	4
	CHO-603	Chemistry of Heterocycles and Medicinal Chemistry	4
	CHO-604	Chemistry of Natural Products and Chiron Approach	4
	OR		
	CHO-605	Pharmaceutical Chemistry	
	CHO-620	Organic Chemistry Practical - V	2
	CHO-621	Organic Chemistry Practical - VI	2
	Total Semester Credits		20
IV	CHO-651	Advanced Synthetic Organic Chemistry	4
	CHO-652	Designing of Organic Synthesis and Asymmetric Synthesis	4
	OR		
	CHO-653	Industrial Material Analysis - II	
	CHO-610	Research Project - I	4
	CHO-660	Research Project - II	6
	CHO-670	Organic Chemistry Practical - VII	2
	Total Semester Credits		20
Total PG-II Credits			40

S.Y. M.Sc. Semester III		
CHO-601	Stereochemistry of Organic Molecules	Number of Credits:04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe stereoechemical principles of ring compounds	
CO2	Explain stereochemistry of cyclic compounds including six-membered rings and rings other than six-membered	
CO3	Predict the product with correct stereochemistry in the given reactions	
CO4	Explain stereochemistry of cyclic compounds including fused and bridged ring systems and Baldwin's Rule	
CO5	(i) Determine the methods used in the separations of racemic mixtures. (ii) Justify the stereochemistry of some important naturally occurring molecules	
CO6	(i) Write a note on stereochemical concepts. (ii) Propose the synthetic strategy and specify stereochemical outcomes	

Unit No.	Title of Unit and Contents
I	Stereochemistry of Six membered rings and their reactions
II	Stereochemistry of rings other than Six-membered ring
III	Fused, Bridged and Caged rings, Baldwin's Rule
IV	Resolution of racemic modification.
V	Structure and Stereochemistry of some naturally occurring compounds Morphine, Quinine, Hardwickiic acid and Camptothecin

Reference Books:

1. Stereochemistry of carbon compounds - E. L. Eliel
2. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen
3. Chemistry of Natural Products - N. R. Krishnaswamy (University Press)
4. Stereochemistry of organic compounds - Nasipuri
5. Stereochemistry of organic compounds - Kalsi
6. Chemistry of Natural products- Kalsi
7. M. E. Wall, M. C. Wani *et al.*, *J. Am Chem. Soc.*, **1966**, 88, 3888
8. M. C. Wani and M. E. Wall, *J. Org. Chem.*, **1969**, 34, 1364
9. Sukh Dev *et al.*, *Tetrahedron Letters*, **1964**, 5(49), 3751

S.Y. M.Sc. Semester III		
CHO -602	Structure Determination by Analytical Methods	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	(i) Define basic principles of spectroscopy and Mass spectrometry and demonstrate their applications (ii) Describe concepts related to chemical shift and coupling constant.	
CO2	(i) Discuss concepts related to ^1H NMR (ii) Illustrate structures from spectral data	
CO3	Demonstrate ^{13}C NMR spectroscopy and experiments related to it.	
CO4	(i) Explain homo and heteronuclear 2D resolved spectroscopy (ii) Analyze 2D spectral data for structure determination	
CO5	(i) Decide structures from fragmentation data and state rules of fragmentation, factors controlling fragmentation, base peak, metastable ion peak in Mass Spectrometry	
CO6	(i) Propose the structure using spectroscopic methods such as - UV, IR, NMR, CMR, Mass spectral data	

Unit. No.	Title of Unit and Contents
I	^1H-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-spin coupling, (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, simplification of complex spectra, nuclear magnetic double resonance, spin decoupling, contact shift reagents, solvent effects, nuclear Overhauser effect (NOE), resonance of other nuclei like ^{31}P , ^{19}F
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 - ^1H) coupling constants

III	2D NMR Techniques: General idea about two dimensional NMR spectroscopy, Correlation spectroscopy (COSY)-Homo COSY (^1H - ^1H), TOCSY, Hetero COSY (HMQC, HMBC), Homo and Hetero nuclear 2D resolved spectroscopy, NOESY and 2D-INADEQUATE experiments and their applications.
IV	Mass Spectrometry: Instrumentation, various methods of ionization (field ionization, field desorption, SIMS, FAB, MALDI, Californium plasma), different detectors (magnetic analyzer, ion cyclotron analyzer, Quadrupole mass filter, time of flight (TOF). Rules of fragmentation of different functional groups, factors controlling fragmentation, HRMS.
V	Problems based on joint application of UV, IR, PMR, CMR, and Mass(Including reaction sequences)

Reference:

1. Introduction to Spectroscopy –D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry -D. H. Williams and I. Flemming Mc Graw Hill
4. Absorption spectroscopy of organic molecules - V. M. Parikh
5. Nuclear Magnetic Resonance –Basic Principles-Atta-Ur-Rehman, Springer-Verlag (1986).
6. One and Two dimensional NMR Spectroscopy - Atta-Ur-Rehman, Elsevier (1989).
7. Organic structure Analysis-Phillip Crews, Rodriguez, Jaspars,Oxford University Press (1998)
8. Organic structural Spectroscopy-Joseph B. Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).5
9. Organic structures from spectra - Field L.D., Kalman J. R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.
10. Spectroscopic identification of organic compound - R M Silverstein,G C Bassler andT C Morrill, John Wiley
11. Introduction to NMR spectroscopy - R. J. Abraham, J. Fisher and P. Loftus Wiley
12. Organic Spectroscopy-William Kemp, E L B with McMillan
13. Spectroscopy of organic molecule - P. S. Kalsi, Wiley, Esterna, New Delhi
14. Organic spectroscopy-RT Morrison and RN Boyd
15. Practical NMR spectroscopy - M. L. Martin, J. J. Delpench, and D J Martyn
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

S.Y. M.Sc. Semester III		
CHO-603	Chemistry of Heterocycles and Medicinal Chemistry	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the formation of heterocycles	
CO2	Discuss various reactions of heterocycles.	
CO3	Predict the products	
CO4	Explain various terms and concepts in medicinal chemistry	
CO5	Determine structural requirements of chemical compounds to be drug	
CO6	Write note on commercialisation of drugs and IPR	

Unit. No.	Title of Unit and Contents
I	Five and six membered heterocycles with one and two hetero atoms: Furan, Pyrrole, Thiophene, Pyridine, Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidines
II	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
III	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
IV	Introduction to drugs, their action and discovery
V	Drug targets
VI	Relation of Drug structure and its chemical and biological properties (QSAR), Synthetic aspects
VII	Antibacterial, Antiviral, Antifungal, Antiprotozoal, Anticancer, Antidiabetic, Anti-Alzheimer drugs

Reference:

1. Heterocyclic Chemistry - T. Gilchrist
2. An introduction to the chemistry of heterocyclic compounds - R M Acheson
Heterocyclic Chemistry - J A Joule and K Mills
3. Principles of modern heterocyclic chemistry- A Paquette
4. Heterocyclic Chemistry - J A Joule and Smith
5. An introduction to medicinal chemistry - Graham L. Patrick 5th Ed. Oxford
6. Introduction to Medicinal Chemistry - Alex Gringauz (Wiley)
7. Foye's Medicinal Chemistry
8. Medicinal Chemistry - A. Burger
9. Medicinal Chemistry - Ashutosh Karr

S.Y. M.Sc. Semester III		
CHO -604	Chemistry of Natural Products and Chiron Approach	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	(i) Describe retrosynthetic analysis of important natural products, roles of reagents, stereochemical and selectivity aspects in synthesis and arrange reagents in synthetic route of target molecules	
CO2	(i) Explain the types terpenoids and alkaloids and mechanism of their biogenesis. (ii) Write notes on biogenesis of natural products.	
CO3	(i) Outline shikimate pathway and predict the product (ii) Write notes related topics	
CO4	(i) Explain carbohydrates, chirons, synthons, chiral drugs (ii) State concept of chiral template (iii) Explain retrosynthetic analysis of different precursors	
CO5	Discuss synthesis of chiral drugs	
CO6	Write notes on chiral drug synthesis and predict the product in synthetic steps	

Unit. No.	Title of Unit and Contents
I	Total Synthesis of some important Natural products: • Taxol • Estrone • Mifepristone • Juvabione (Mori and Matsui synthesis and Pawson and Cheung Synthesis) • Fredericamycin A • Reserpine
II	Biogenesis: The building blocks and construction mechanism of • Terpenoids – Mono, Sesqui, Di and Triterpenoids and cholesterol • Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan. • The shikimate pathway - cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbens, isoflavanoids and terpenoid quinones

III	Chiron Approach: Introduction . 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 Chiral Drugs: Introduction of chiral drugs, Eutomer, Distomer and eudesmic ratio. a) with no side effects b) with undesirable side effects Synthesis and pharmacological activity of S-Ibuprofen, S-Metaprolol, Indinavir sulfate, Dextropropoxyphen, (+)- Ephedrine, Griseofulvin, R-Indacrinnone, hydrochloride, S-Captopril
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References:

1. Chemistry of Natural products – Kalsi
2. Principles of organic synthesis by R. O. C. Norman and J. M. Coxon; Chapman and Hall
3. Classics in organic synthesis – K. C. Nicolaou & E. J. Sorensen⁴.
4. J. Indian Inst. Sci., 81, 287 (2001)
5. Medicinal Natural Products - A Biosynthetic approach by Paul M. Dewick 2nd Ed.(Wiley)
6. Secondary metabolism - J. Mann, 2nd edition.
7. Chemical aspects of Biosynthesis - J. Mann (1994).
8. i) J.C.S. Perkin Transactions II, **1973**, 288-292ii) J. Am. Chem. Soc., **1955**, 77, 432-437
9. Advanced Organic Chemistry- Carey and Sundberg Part B 5th Ed.
10. Organic Chemistry - R. P. Morrison and R. N. Boyd
11. Organic Chemistry - I. L. Finar, volume II
12. Chiron Approach in organic synthesis - S. Hanessianh
13. Pharmaceutical Chemistry and drug synthesis - Rot and Kleeman
14. Drug Design - E. J. Arienes

S.Y. M.Sc. Semester III		
CHO -605	Pharmaceutical Chemistry	Number of Credits: 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	List the importance of FDA in pharmaceutical industries. Define basic concepts related to pharmaceutical chemistry.	
CO2	Discuss and explain various pharmaceutical concepts and techniques of analysis.	
CO3	Illustrate the role of drug activity in pharmaco-kinetics and dynamics. Solve the numericals based on pharmaceutical concepts.	
CO4	Analyze different pharmaceutical samples using different analytical techniques.	
CO5	Compare different dosage forms, route of administration, pattern of drug release and explain the importance in drug administration.	
CO6	Propose method for analyzing pharmaceutical samples based on their properties.	

Unit. No.	Title of Unit and Contents
I	Role of FDA in Pharmaceutical Industries: Definitions of Drug & Cosmetics, Substandard Drugs, Role of FDA, Introduction to New Drug, Development of New Drugs- Selection of Area, Phase I, Phase II, Phase III Application to FDA for formulation and marketing for new drug, introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for maintenance and calibration, Document maintenance in pharmaceutical Industry
II	Dosage form and route of administration: Introduction, dosage and their types. Route of administration, factors affecting on dosage, Dosage form analysis: Tablets, different types of tablets, additives used in tablet manufacture. Analysis of aspirin tablet, Capsules, types of capsules, (Rifampicin), Powders (Sodium benzoate), Solutions (saline NaCl), Suspensions (barium sulphate), (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), Aerosols (salbutamol), Problems based on assay of these materials.

III	Evaluation of solid dosage Forms-Tablets and capsule Quality: Hardness, Friability, Tablet thickness, Weight variation test, Content uniformity test, Viscosity and pH Measurement, disintegration, dissolution, stability, Disintegration and Dissolution, rate of dissolution and types dissolution apparatus, ii. Moisture / water content by Karl-Fischer titration- Principle, types of Karl Fischer titration, preparation and standardization of Karl Fischer reagent. iii. Sterilization: Methods for Sterilization (Physical and chemical method), Applications.
IV	Biological Tests & Assay: Introduction to biological assay, Biological assay of Heparin sodium, Determination of Amylase activity, Determination of Photolytic Activity, Test for Insulin in solution, Biological Assay of Tetanus Antitoxin, Test for Undue Toxicity Microbiological Tests and Assays: Microbiological test for Antibiotics Standard preparation and units of activity, Test organisms and Inoculums, Cylinder-plate assay receptacles, Turbidimetric assay receptacles, Assay Designs, Cylinder plate or Cup- plate method, Two level fractional assay, Test for Sterility
V	Pharmacology: Pharmacokinetics and dynamics Pharmacokinetics: Introduction, ADME process, pharmacokinetics models (one compartment, two compartment and multi compartment), bioavailability, Constant-rate infusion- administration rate, kinetics of elimination –clearance, first order kinetics, zero order kinetics and Half- life). Pharmacodynamics: Introduction, principle of drug action, mechanism of drug action, enzymes-enzyme inhibition, Receptors- Agonists, Antagonism, Partial agonists, function of receptors, dose-response relationship, drug potency and efficiency, therapeutic efficiency, drug selectivity and specificity, Non-receptor mechanisms.
VI	Sources of Impurities in Pharmaceutical Raw Materials & Finished Products: a. Raw materials, Method of manufacture, Atmospheric contaminations, Cross contamination, Microbial contamination, Container contamination, Packaging errors, Chemical instability, Temperature effect and Physical changes. b. Shelf Life of Pharmaceutical Product: shelf life of Pharmaceutical product and determination of shelf life. Water for pharmaceutical use. c. Limit test: Limit tests for aluminum, arsenic, iron, lead, potassium, sulphate, chloride, heavy metals, d. Ash value: acid soluble ash, acid insoluble ash, sulphated ash, Loss on drying loss on ignition.

References

1. Indian Pharmacopeia Volume I and II.
2. Practical Pharmaceutical chemistry third edition volume 1. By A. H. Beckett & J. B. Stenlake.
3. Remington's Pharmaceutical sciences.
4. Ansel's Pharmaceutical Analysis.
5. Aymanns C, Keller F, Maus S, et al. Review of pharmacokinetics and pharmacodynamic and the aging kidney. Clin J Am SocNephrol.
6. Pharmaceutical Analysis by Ashutosh Kar.

S.Y. M.Sc. Semester III		
CHO-620	Organic Chemistry Practical – V	Number of Credits : 02
Course Outcome (CO) On completion of the course, the students will be able to:		
CO1	Describe mechanism and particulars regarding nature of reactants, reagents and products, safety measures, reaction conditions and work up of the experiment.	
CO2	Outline experiment involving single stage conversion of starting material into the product and able to assemble apparatus for setting for experiment (guard tube, distillation unit, Hickman head)	
CO3	Carry out experiments based on rearrangements and aromatic substitution reactions	
CO4	Arrange experiments based on oxidation, reduction, addition, condensation and photochemical reaction.	
CO5	Carry out experiments related to heterocycles synthesis	
CO6	Examine progress of the reaction and compile the results obtained.	

Single stage preparations based on regio-selective and chemo selective

Principles Single stage preparations comprising of reactions involving:

- Rearrangements,
- Aromatic electrophilic substitution
- Aromatic nucleophilic substitution
- Reduction
- Ylides
- Grignard reaction
- Photochemical reaction
- Condensation reaction
- Acetyl derivatives
- Heterocyclic synthesis
- Self-redox
- Wittig reaction

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)

S.Y. M.Sc. Semester III		
CHO - 621	Organic Chemistry Practical – VI	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	(i) Describe mechanism and particulars regarding nature of reactants, reagents and products, safety measures, reaction conditions and work up of the experiment (ii) Discuss importance of yield and purity of the product of first step in two stage synthesis	
CO2	Outline experiment involving two stage conversion of starting material into the products and able to assemble apparatus for setting for experiment (guard tube, distillation unit, Hickman head)	
CO3	Carry out experiments based on rearrangements and aromatic substitution reactions	
CO4	Arrange experiments based on oxidation, reduction and condensation	
CO5	Carry out experiments related to heterocycles synthesis	
CO6	Examine progress of the reaction in both steps and compile the results obtained	

Two stage preparations involving:

- Aldol reaction
- Epoxidation
- Oxidation
- Reduction
- Condensation
- Acetylation
- Schiff base formation
- Cyclization
- Alkylation
- Rearrangement
- Nitration
- Hydrolysis
- Enamine
- Halogenation
- Oxime

References:

1. A Textbook of Practical Organic Chemistry - A. I. Vogel - ELBS with Longman, 5thEd., (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)

S.Y. M.Sc. Semester IV		
CHO -651	Advanced Synthetic Organic Chemistry	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Explain role of metals as catalyst and contribution of transition metals as catalyst.	
CO2	Discuss the role of various transition metals as catalysts in C-C bond formation	
CO3	Outline the concepts of MCR, Click chemistry and means of ring formation and illustrating their applications	
CO4	Explain reactions of nonmetals and their applications	
CO5	Discuss metal mediated metathesis in ring formation and ring opening	
CO6	Compile details of reactions involving rearrangements and fragmentation.	

Unit. No.	Title of Unit and Contents
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
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
III	Multi-component reactions: Ugi, Passerini, Biginelli and Mannich reactions
IV	Ring formation reactions: Pausan-Khand, Bergman and Nazarov cyclization
V	Click chemistry: criterion for click reaction, Sharpless azides cycloadditions
VI	Metathesis: Grubbs 1st and 2nd generation catalyst, Olefin cross coupling (OCM), ring closing (RCM) and ring opening (ROM) metathesis, applications
VII	Use of Boron and Silicon in organic synthesis
VIII	Other important reactions: Baylis Hilman, Eschenmoser-Tanabe fragmentation, Mitsunobu reaction

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

S.Y. M.Sc. Semester IV		
CHO -652	Designing of Organic Synthesis and Asymmetric Synthesis	Number of Credits: 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Outline the important classical and modern reactions used in organic synthesis and write a note on	
CO2	Explain the concept of umpolung, methods of protection and deprotection and their application in organic synthesis	
CO3	Predict the correct product or a choice of reagents to accomplish the synthesis of useful organic molecules.	
CO4	Predict the product with correct stereochemistry based on choice of reagents and conditions	
CO5	(i) Explain the concept of asymmetric synthesis and determine the use of chiral reagents, catalysts, auxiliaries and solvents in asymmetric synthesis; (ii) Write notes on different methods for asymmetric synthesis; (iii) Identify the role and use of organocatalysts in asymmetric synthesis	
CO6	Design the synthesis of given target molecules using retrosynthetic analysis to work out and compare alternative syntheses of complex organic molecules	

Unit. No.	Title of Unit and Contents
I	Designing Organic Synthesis: - Retrosynthesis: one-group disconnection, two-group disconnection, Illogical two-group disconnection, Special methods for small rings, Strategy - Protection and de-protection of hydroxyl, amino, carboxyl, ketone and aldehyde functions - Umpolung in organic synthesis
II	Asymmetric Synthesis: - Chirality transfer, Asymmetric inductions; Chiral pools, Chiral auxiliaries and chiral reagents - Organocatalysis - Asymmetric Reactions: - Asymmetric oxidations: Epoxidation (Sharpless, Shi, Jorgensen and etc.), Asymmetric Dihydroxylation, Aminohydroxylation, Asymmetric Reduction: Asymmetric 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; Michael Reaction, Henry Reaction (Nitro aldol), Baylis-Hillman-Morita reactions. - Stereoselective addition of nucleophiles to carbonyl group: Re-Si face concepts, Cram's rule, Felkin Anh rule, Cram's chelate model, etc. - Enzyme catalyzed reactions binding mechanism of enzymes

References:

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

CHO-653	Industrial material analysis-II	Number of Credits: 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	State composition, types and functions of various industrial material and food nutrients.	
CO2	Outline the basic techniques used to determine carbohydrates, proteins and lipids.	
CO3	Discuss different sampling methods of industrial materials.	
CO4	Explain various food processing methods in food preservation techniques.	
CO5	Identify and analyze components from various industrial samples.	
CO6	Formulate and solve numericals to determine different components present in industrial material.	

Unit. No.	Title of Unit and Contents
I	Analysis of soaps and detergents: (15 L) General scheme of analysis, sampling, alcohol soluble materials, moisture and volatile matter, active ingredient and equivalent combined SO_3^{3-} , Tests for soaps and detergents: total fatty acids, fatty anhydride combined alkali, and anhydrous soap, Unsaponified and unsaponifiable matter, Free alkali or free acid, titer test, Iodine value, saponification value, free glycerol, alkalinity, chlorides, silicate, phosphate, borates, UV spectroscopic analysis of detergents, Determination of sodium alkyl benzene sulfonate, sodium toluene sulfonate, sodium xylene sulfonate, germicides
II	Analysis of Paints and Pigment (15L) Introduction, test on the total coating, water content, separation of pigment binder, and thinner of solvent type coating, separation of pigment binder, and thinner of latex paints, Identification of the binder, polymer resins and oils, plasticizer, Analysis of the vehicle, Identification and Analysis of pigments, outline of general procedure, HCL insoluble, Titanium dioxide, total lead, acid soluble Al and Fe, acid soluble calcium, total zinc, antimony oxide, total sulfate, total carbonate), identification and analysis of thinners.

III	Food analysis (15L) a. Carbohydrates: Introduction, Analysis of carbohydrates from food sample by different method i) Fehling's solution, ii) Wu method iii) total Anthrone method, iv) Estimation of pectic substances. b. Proteins: Definitions and functions, Analysis of proteins by Kjeldahl's method, Lowry method, ninhydrin method, Estimation of food grain for methionine content. c. Lipids: Estimation of oil, free fatty acids, Saponification value, iodine value, acid value of oil, peroxide value of oil and rancidity.
IV	Analysis of food products: (5L) Milk and milk products, tea, coffee and beverages. flour, starch, honey, jams and edible oils.
V	Food processing and Preservation: (10 L) a. Food processing: Refining milling, canning, concentration, freezing Drying, irradiation, pasteurization, and sterilization. b. Determination of food preservatives: Analysis of inorganic and organic preservatives, such as SO₂ by Tanners method, Nitrate and nitrites, boric acid, Benzoic acid, 4-hydroxybenzoate, ascorbic acid, Analysis of food additives: sweeteners and colors.

References:

1. Standard methods of chemical analysis, volume 3, Part-B, F.J. Welcher
2. Practical Clinical Biochemistry, Gowenlock, CBS published, 6th Ed.
3. Chemical analysis of food by Pearson.
4. Practical Pharmaceutical Chemistry by Beckett.
5. Biochemical methods of analysis S. Sadasivam and A. Manickam, Narosa Publication

CHO-610	Research Project - I	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Fix the area of research considering possible applications	
CO2	Check the novelty of the research problem through literature survey	
CO3	Design the scheme/outline of research work	
CO4	Prepare the estimation of various budget heads	
CO5	Prepare execution plan for the proposed project work	
CO6	Prepare the project proposal	

CHO-660	Research Project - II	Number of Credits : 06
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Plan for experimental work, independently defined scientific problem using different analytical tools	
CO2	Isolate, purify and analyze the products obtained	
CO3	Interpret results and draw conclusions	
CO4	Compile and justify findings of the experiments. Compare and criticize results based on scientific literature.	
CO5	Articulate ethical scientific experiment execution and art of reporting.	
CO6	Appraise the best presentation approach for their project conclusions in the form of a dissertation and research articles	

CHO-670	Organic Chemistry Practical - VII	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe principles of green chemistry, particulars regarding nature of reactants, reagents and products, safety measures, reaction conditions and work up of the experiment.	
CO2	Outline experiment involving solvent free conditions, room temperature reactions.	
CO3	Carry out experiments making use of eco-friendly reagents, catalysts and reaction conditions. Analyze the results.	
CO4	Arrange experiment for synthesis of agrochemicals	
CO5	Carry out experiments for isolation of natural products.	
CO6	Examine progress of the reaction and compile the results obtained.	

Green Chemistry and Chemical Biology Experiments

- Solvent free reactions
- Room temperature reactions
- Use of environment friendly and non-hazardous reagents
- Use of environment friendly catalysts
- Atom economic reactions
- Rearrangements
- Condensation reactions
- Aldol reaction
- Fermentation reaction

Experiments in applied chemistry:

- Isolation of Natural products
- Synthesis of Schiff bases for dyes
- Pharmaceutical scaffold synthesis
- Industrially useful Monomers
- Synthesis of agrochemicals

References:

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