Fergusson College (Autonomous) Pune-4

Learning Outcomes-Based Curriculum

for

M.Sc. II - Organic Chemistry

With effect from June 2024

Programme 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 OR	Chemistry of Natural Products and Chiron Approach	4
	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 OR	Designing of Organic Synthesis and Asymmetric Synthesis	4
	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

Semester III

Course Code	CHO-601
Course Title	Stereochemistry of Organic Molecules
Number of Credits	4
CO	**Description**
CO1	Describe strereochemical 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
Unit I	Stereochemistry of Six membered rings and their reactions
Unit II	Stereochemistry of rings other than Six-membered ring
Unit III	Fused, Bridged and Caged rings, Baldwin's Rule
Unit IV	Resolution of racemic modification.
Unit V	Structure and Stereochemistry of some naturally occurring compounds Morphine, Quinine, Hardwickiic acid and Camptothecin

References:

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

Course Code	CHO -602
Course Title	Structure Determination by Analytical Methods
Number of Credits	4
CO	**Description**
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 ^{1}H 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 rulesof 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
Unit I	**^{1}H-NMR Spectroscopy**: History of NMR, Chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and mercaptans), chemical exchange, effect of deuteration (Driving force), spin-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
Unit II	**^{13}C NMR spectroscopy**: FT NMR, Types of ^{13}C NMR Spectra: un-decoupled, Proton decoupled, off resonance, APT, INEPT, DEPT, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts, Homo nuclear (^{13}C-^{13}C) and Hetero nuclear (^{13}C-^{1}H) coupling constants
Unit III	**2D NMR Techniques**: General idea about two dimensional NMR spectroscopy, Correlation spectroscopy (COSY)-Homo COSY (^{1}H-^{1}H), TOCSY, Hetero COSY (HMQC, HMBC), Homo and Hetero nuclear 2D resolved spectroscopy, NOESY and 2D-INADEQUATE experiments and their applications.

Unit IV	**Mass Spectrometry**: Instrumentation, various methods of ionization (field ionization, fielddesorption, SIMS, FAB, MALDI, Californium plasma), different detectors (magnetic analyzer, ion cyclotron analyzer, Quadrupoule mass filter, time of flight (TOF). Rules of fragmentation of different functional groups, factors controlling fragmentation, HRMS.
Unit V	Problems based on joint application of UV, IR, PMR, CMR, and Mass(Including reaction sequences)

References:

1. Introduction to Spectroscopy –D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry -D. H. Williams and I. Flemming Mc Graw Hill
4. Absorption spectroscopy of organic molecules - V. M. Parikh
5. Nuclear Magnetic Resonance –Basic Principles-Atta-Ur-Rehman, Springer-Verlag (1986).
6. One and Two dimensional NMR Spectroscopy - Atta-Ur-Rehman, Elsevier (1989).
7. Organic structure Analysis-Phillip Crews, Rodriguez, Jaspars,Oxford University Press (1998)
8. Organic structural Spectroscopy-Joseph B. Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).5
9. Organic structures from spectra - Field L.D., Kalman J. R. and Sternhell S. 4^{th} Ed. John Wiley and sons Ltd.
10. Spectroscopic identification of organic compound - R M Silverstein,G C Bassler andT C Morril, John Wiley
11. Introduction to NMR spectroscopy - R. J. Abrahm, J. Fisher and P. loftus Wiley
12. Organic spectroscopy-William kemp, E L B with McMillan
13. Spectroscopy of organic molecule - 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 Martyin
16. Spectroscopic methods in organic chemistry - D H Willson, I Fleming
17. Spectroscopy in organic chemistry - C N R Rao and J R Ferraro
18. NMR –Basic principle and application - H Guntur
19. Interpretation of NMR spectra - Roy H Bible
20. Mass spectrometry organic chemical applications - J H Banyon

Course Code	CHO -603
Course Title	Chemistry of Heterocycles and Medicinal Chemistry
Number of Credits	4
CO	**Description**
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
Unit I	Five and six membered heterocycles with one and two hetero atoms: Furan, Pyrrole, Thiophene, Pyridine, Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidines
Unit 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
Unit 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
Unit IV	Introduction to drugs, their action and discovery
Unit V	Drug targets
Unit VI	Relation of Drug structure and its chemical and biological properties (QSAR), Synthetic aspects
Unit VII	Antibacterial, Antiviral, Antifungal, Antiprotozoal, Anticancer, Antidiabetic, Anti-Alzheimer drugs

References:

1. Heterocyclic Chemistry - T. Gilchrist
2. An introduction to the chemistry of heterocyclic compounds - R M Acheso
   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

Course Code	CHO-604
Course Title	Chemistry of Natural Products and Chiron Approach
Number of Credits	4
CO	**Description**
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
Unit I	**Total Synthesis of some important Natural products:** • Taxol • Estrone • Mifepristone • Juvabione (Mori and Matsui synthesis and Pawson and Cheung Synthesis) • Fredericamycin A • Reserpine
Unit 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
Unit 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

References:

1. Chemistry of Natural products - Kalsi
2. Principles of organic synthesis by R. O. C. Norman and J. M. Coxon; Chapman andHall

3. Classics in organic synthesis – K. C. Nicolaou & E. J. Sorensen4.
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

Title of the Course and Course Code	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

pharmaco dynamic and the aging kidney. Clin J Am SocNephrol.

6. Pharmaceutical Analysis by Ashutosh Kar.

Course Code	**CHO-620**
Course Title	Organic Chemistry Practical – V
Number of Credits	2
CO	**Description**
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

PrinciplesSingle stage preparations comprising of reactions involving:

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

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)
   Advanced Practical Organic Chemistry - N. K. Vishnoi - Vikas 2nd Ed., (1996)

Course Code	CHO-621
Course Title	Organic Chemistry Practical – VI
Number of Credits	2
CO	**Description**
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)

Semester IV

Course Code	**CHO-651**
Course Title	Advanced Synthetic Organic Chemistry
Number of Credits	4
CO	**Description**
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 non metals 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
Unit I	Transition metal complexes in organic synthesis; only Pd, Ni, Co, Fe (Metal mediated C-C and C-X bond formation reactions: Suzuki, Heck, Sonogashira, Stille, Fukuyama, Kumada, Hiyama, Negishi, Buchwald-Hartwig, Noyori, Reppe, Oxo process
Unit II	C=C formation reactions: Wittig, Horner-Wordworth-Emmons, Shapiro, Bamford-Stevens, McMurry, Julia-Lythgoe and Peterson olefination reactions, Titanium-carbene mediated olefination: Tebbe, Petasis and Nysted reagent
Unit III	Multi-component reactions: Ugi, Passerini, Biginelli and Mannich reactions
Unit IV	Ring formation reactions: Pausan-Khand, Bergman and Nazerov cyclization
Unit V	Click chemistry: criterion for click reaction, Sharpless azides cycloadditions
Unit VI	Metathesis: Grubbs 1st and 2nd generation catalyst, Olefin cross coupling (OCM), ring closing (RCM) and ring opening (ROM) metathesis, applications
Unit VII	Use of Boron and Silicon in organic synthesis
Unit 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, 5^{th} edition (2007)
8. Guidebook to organic synthesis – R. K. Meckie, D. M. Smith and R. A. Atken
9. Organic synthesis - Robert E. Ireland
10. Strategic Applications of named reactions in organic synthesis - Laszlo Kurti and Barba

Course Code	CHO-652
Course Title	Designing of Organic Synthesis and Asymmetric Synthesis
Number of Credits	4
CO	**Description**
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
Unit 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
Unit 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, 5^{th} edition (2007)
4. Asymmetric Reactions and Processes in Chemistry - Ernest L. Eliel
5. Catalytic Asymmetric Synthesis: 2^{nd} 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

Title of the Course and Course Code	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: total fatty acids, fatty anhydride combined alkali, and anhydrous soap, Unsponified and unsaponifiable matter, Free alkali or free acid, titer test, Iodine value, saponification value, free glycerol, Tests for synthetic detergents: Unsulfonated or unsulfated matter, ester SO_3, Combined alcohols, total combined SO3, Alkalinity, chlorides, silicate, phosphate, borates, UV spectroscopic analysis of detergents: Biodegradability of detergents, Determination of sodium alkyl benzene sulfonate, determination of sodium toluene sulfonate, determination of sodium xylene sulfonate, determination of germicides in soaps and detergents
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, Identification of polymer resins and oils, Identification of plasticizer, Analysis of the vehicle, Identification and Analysis of pigments, Identification of inorganic pigments, Analysis of white and tinted 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) analysis of coloured pigments, Black pigments, other pigments, identification and analysis of thinners.

III	**Food analysis (15L)** **a. Carbohydrates: Introduction,** Analysis of carbohydrates from food sample by different method i) volumetric determination by Fehling's solution, ii) Colorimetric analysis of carbohydrates by Folin Wu method iii) total carbohydrates by Anthrone method, iv) Estimation of pectic substances (gravimetric and colorimetric method). **b. Proteins:** Definitions and functions, Analysis of proteins by Kjedahl's method, analysis of protein by Lowry method, Estimation of amino acids by colorimetric method, Estimation of food grain for methionine content. **c. Lipids**: Estimation of oil in oilseeds, Estimation of free fatty acids, Saponification value of oils, iodine value, Determination of acid value of oil, determination of peroxide value of oil, Identification and quantification of fatty acids.
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.** **ood processing:** Refining milling, canning, concentration, freezing Drying, irradiation, pasteurization, and sterilization. **b.** **etermination of food preservatives:** Analysis of preservatives: Inorganic and organic preservatives, such as SO_2 by Tanners method, Nitrate and nitrites, boric acid , Benzoic acid, 4-hydroxybenzoate,ascorbic acid, Sweeteners: Saccharine, Colours: Identification by general methods, Natural colours

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

Course Code	CHO-610	
Title of the Course	**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	

Course Code	CHO-660	
Title of the Course and Course Code	**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	

Course Code	CHO-670
Course Title	Organic Chemistry Practical - VII
Number of Credits	2
CO	Description
CO1	Describe principles of green chemistry, particulars regarding nature of reactants, reagents and products, safety measures, reaction conditions andwork up of the experiment.
CO2	Outline experiment involving solvent free conditions, room temperaturereactions.
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

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