Enclosure-II-2.1

Yogi Divine Society inspired,

Sarvodaya Kelavani Samaj managed,

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot

(Affiliated to Saurashtra University, Rajkot)

Re-Accredited at 'A' Level by NAAC

STAR college Scheme & Status by MST-DBT

UGC- College with Potential for Excellence (CPE)

UGC-DDU KAUSHAL Kendra

GAAA – Highest Grade A-1 by KCG, Government of Gujarat

GPCB-Government of Gujarat approved Environment Audit Center

UGC-Autonomous College

DEPARTMENT OF CHEMISTRY

M.Sc. Pharmaceutical Organic Chemistry

Enclosure- II D

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)

Affiliated to Saurashtra University, Rajkot

Department of Chemistry

M.Sc. PHARMACEUTICAL ORGANIC CHEMISTRY

OBJECTIVES OF THE PROGRAM: M. Sc. Pharma. Organic Chemistry:

The curriculum is devised to accomplish the following program objectives which students shall accomplish by the end of their post-graduation study.

1. To impart education at advanced level in a more holistic way and to enthuse students for the subject.
2. To provide flexibility in teaching & learning endowed with space for slow & fast learners.
3. To train the students to make them confident and capable of accepting new challenges in the field of Pharmaceutical Organic Chemistry.
4. To update the students about the current status and new developments in the Pharmaceutical Organic Chemistry.
5. To expose the students to research in Chemistry and to promote the students for an independent research career.
6. To make the students aware of the impact of Chemistry on health & environment and to enable them to imbibe the concept of sustainable development.
7. To foster entrepreneurial spirit in the students and to create linkages with various industries/research centres and others to expose the students to the expectations of the industries & the society.

SCHEME OF INSTRUCTION AND EXAMINATIONS

For Students Admitted from A.Y. 2016-2017 & Onwards

Semester-I							
Subject Code	**Course**	**Hrs. of Instruction**	**Exam Duration (Hrs)**	**Max. Marks**			**Credit**
				CIA	**SEE**	**Total**	
Part - I							
16PCHCC01	**Core 1:** Inorganic Chemistry	4	3	30	70	100	4
16PCHCC02	**Core 2:** Organic Reactions, Rearrangements & Reagents	4	3	30	70	100	4
16PCHCC03	**Core 3:** Physical Chemistry	4	3	30	70	100	4
16PCHCC04	**Core 4:** Pharmaceutical Engineering-I	4	3	30	70	100	4
16PCHCC05	**Core Practical-1:** Inorganic, Organic, Physical Chemistry, Pharmaceutical Engineering-I Practical	12	12	80	120	200	6
Part - II							
16PCHCE01	IT Tools for Chemist	1	1	50	-	50	1
		29				**650**	**23**
Part - III							
16PVE01	Value Education	1	-	Remarks			1
		30				**650**	**24**

Semester-II							
Part - I							
16PCHCC06	**Core 5:** Chemistry of Natural Products	4	3	30	70	100	4
16PCHCC07	**Core 6**: Organic Synthesis: A Disconnection Approach	5	3	30	70	100	5
16PCHCC08	**Core 7**: Selected Topics in Pharmaceutical Chemistry	4	3	30	70	100	4
16PCHCC09	**Core 8**: Pharmaceutical Engineering-II	4	3	30	70	100	4
16PCHCC10	**Core Practical-2:** Chemistry of Natural product, Pharmaceutical Chemistry, Pharmaceutical Engineering-II Practical	12	12	80	120	200	6
Part - II							
16PCHCE02	Scientific Writing (Research)	1	-	50	-	50	1
		30				**650**	**24**

Semester-III							
Part - I							
16PCHCC11	**Core 9:** Pharmaceutical Technology	4	3	30	70	100	4
16PCHCC12	**Core 10**: Medicinal Chemistry-I	4	3	30	70	100	4
16PCHCC13	**Core 11**: Stereo Chemistry	4	3	30	70	100	4
16PCHCC14	**Core 12**: Computer Based Test	-	-	50	-	50	1
16PCHDC01/ 16PCHDC02	**DSE – Core -1:** Separation Techniques **OR** Technologies in Chemical Industries	4	3	30	70	100	4
16PCHCC15	**Core Practical-3:** Pharmaceutical Technology, Medicinal Chemistry	10	9	60	90	150	5
16PCHDC03/ 16PCHDC04	**DSE – Core -1 Practical**: Separation Techniques **OR** Technologies in Chemical Industries Practical	2	3	20	30	50	1
-	Dissertation	1	-	Evaluated at the end of Sem-IV			-
Part - II							
16PCHCE03	Pilot Plant Operation	1	-	50	-	50	1
		30				**700**	**24**

Semester-IV							
Part - I							
16PCHCC16	**Core 13**: Heterocyclic Chemistry	5	3	30	70	100	5
16PCHCC17	**Core 14**: Medicinal Chemistry -II	4	3	30	70	100	4
16PCHCC18	**Core 15**: Dissertation	16	-	60	90	150	10
16PCHDC05/ 16PCHDC06	**DSE – Core -2:** Modern Analytical Techniques **OR** Chemical Reaction Engineering	4	3	30	70	100	4
Part - II							
16PCHCE04	Instrumental Training	1	-	50	-	50	1
		30				**500**	**24**
	TOTAL					**2500**	**96**

SEMESTER III

16PCHCC11	Core 9: Pharmaceutical Technology	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand & write formulations and evaluations methods for various types tablets & capsules
- Illustrate requirement for preparation of sterile dosages & liquid dosage forms
- Understand and Describe cosmeticology and their preparations

Unit 1. Tablet **(12 Hrs.)**

(a) Definition, Advantages and disadvantages, Introduction to types of tablets**,** formulation of different types of tablets; excipients, granulation techniques, machinery for large scale granulation and compression, physics of tablet making, In process controls, processing problems and remedies,

(b) Evaluation (Pharmacopoeial and nonpharmacopoeial test) and equipments. Introduction of mouth dissolving tablets, buccal tablets, floating tablets, tablets of colon drug delivery, matrix tablets.

(c) Coating of Tablets: Objectives, types of coating, film forming materials, formulations of coating solution, equipments for coating, coating process, evaluation of coated tablets , coating defects.

Unit 2. Capsules **(10 Hrs.)**

Hard Capsules:

Definitions, Advantages, disadvantages, Ideal requirements, Production of Hard capsules (Gelatin and non-gelatin e.g. vegetable), Capsule storage, size of capsules, formulation and methods of capsule filling, problems and remedies, quality control.

Soft Gelatin Capsules:

Formulation of shell and capsule coat, and quality control.

Unit 3. Sterile Dosage Forms **(10 Hrs.)**

Definitions, Advantages, Disadvantages, Ideal requirements and Formulation of sterile dosage forms, Water for injection-Preparation, Design and requirements for production area- Aseptic techniques, sources of contamination and methods of prevention, design of aseptic area, laminar flow benches, containers and closures, methods of filling including form fill and seal technology. Evaluation of sterile dosage forms.

Unit 4. Cosmeticology and Cosmetic Preparations **(8 Hrs.)**

Fundamentals of cosmetic science, formulation, preparation and packaging of cosmetics for skin - Sunscreen, moisturizers, cold cream, and vanishing cream, hair - Shampoo and conditioners, dentifrice- powders, gels, paste and manicure

preparations like- nail polish, lipsticks, eye lashes, baby care products, shaving cream, hygienic products.

Unit 5. Liquid Dosage Forms (8 Hrs.)

Introduction, advantages and disadvantages, types of additives used vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavors, etc.

Reference Books

1. The Theory and Practice of Industrial Pharmacy by L Lachman, H Lieberman and J
2. Kanig. Gennaro, Alfonso R., Remington: The Science and Practice of Pharmacy, Vol-I & II, Lippincott Williams & Wilkins, New York.
3. Pharmaceutical Dosage Forms and Drug Delivery Systems by Ansel& others.
4. Pharmaceutics: The Science of Dosage Form Design by Michael E. Aulton

SEMESTER III

16PCHCC12	Core 10: Medicinal Chemistry -I	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand and describe process of drug discovery and development in medicinal chemistry
- Illustrate pharmakokinetics and pharmacodynamic profile for drug & write receptor drug interaction phenomena.
- Predict and describe drug classification, mechanism of action of drugs, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures their off.

Unit 1. An introduction to the subject of medicinal chemistry (10 Hrs.)

History and development of medicinal chemistry, Physiochemical properties of drug molecules influencing biological activity

Receptors and Drug action: Types of receptors, Theories of Drug-Receptor, Interactions.

Pharmacokinetics and Pharmacodynamics: Introduction, Route of drug absorption, Factor influencing distribution of drug, Biotransformation of the drug, Drug excretion, Concept of drug receptor interactions, Study of LD_{50}, ED_{50}, MIC and MEC etc.

Unit 2. Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures of selected drugs of following categories to be covered. **(12 Hrs.)**

Drugs acting on gastrointestinal tract:

- **Antacids, Antisecretory, Antidiarrheals, Laxatives**
  Synthesis: Ranitidine, Omeprazole

Drugs Acting on CNS:

- **CNS stimulants: Analeptics, Antidepressants**
  SAR: Tricyclic antidepressants
  Synthesis: Amphetamine, Nikethamine, Imipramine.
- **CNS Depressants: General and local anesthetics, Sedative and hypnotics, Antiepileptics, Antipsychotics**
  SAR: Benzoic acid derivatives, Barbiturates, Benzodiazepines, Phenothiazines
  Synthesis: Lignocaine, Procaine, Phenobarbitone, Chlordiazepoxide, Meprobamate, Phenytoin, Sodium valproic acid, Carbamazepine, Chlopromazine

Unit 3. Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures of selected drugs of following categories to be covered. **(12 Hrs.)**

Chemotherapeutic Agents:

- **Synthetic Antibacterial Agents / Antimicrobial Agents:**
  SAR: Sulfonamides, Quinolones
  Synthesis: Sulfamethoxazole, Sulfasalazine, Trimethoprim, Ciprofloxacin
- **β-Lactam Antibiotics:**
  SAR: Cephalosporins, Penicillins
- **Antimycobacterial Agents:**
  Synthesis: Ethambutol, Isoniazid, Pyrazinamide, Clofazimine, PAS.
- **Antifungal Agents:**
  Synthesis: Clotrimazole, Ketoconazole, Fluconazole

Unit 4. Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures of selected drugs of following categories to be covered. **(10 Hrs.)**

Chemotherapeutic Agents:

- **Antiprotozoal Agents: Antimalarial, Antiamoebic Agents**
  SAR: Quinolines
  Synthesis: Metronidazole, Ornidazole, Chloroquine, Primaquine, Pyrimethamine.
- **Anthelmintics:**
  Synthesis: Albendazole, Mebendazole.
- **Antiviral and Anti-HIV Agents:**
  Synthesis: Amantadine
- **Antineoplastic agents:**
  Synthesis: Chlorambucil, Cyclophosphamide, Methotrexate, Fluorouracil

Unit 5. Combinatorial Chemistry: (4 Hrs.)

The Principle and design of combinatorial chemistry, Pool and split method for peptide synthesis, Parallel synthesis, Furka's mix and split technique, Solid support method.

Reference Books

1. Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge.
3. An Introduction to Drug Design, S. S. Pandey and J.R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Sixth Edition, Ed.M.E.vWolff, John Wiley.

5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley. Pharmaceutical Substances., Kleemann, Vol-I & II., Fourth edition., Thieme

SEMESTER III

16PCHCC13	Core 11: Stereochemistry	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand basics of stereochemistry, Classify isomers, predict absolute configurations of organic molecules
- Illustrate resolution of racemic mixture, determine optical purity, compare and decide stereospecific and stereoselective reactions & their products.
- Understand and describe conformations & reactivity of cyclohexane
- Describe stereochemistry of substitutions, elimination & addition reactions & determine their products.

Unit 1. Fundamental of Stereochemistry (14 Hrs.)

Chirality, Isomers, Classification of stereoisomerism, Optical isomerism, Conventions for D, L and R, S- system, Interconversion between Fischer and Three-dimensional formulas with one stereocenter, Stereoisomerism for more than one stereogenic unit, Threo & Erythro, Geometrical isomerism, Cis/Trans, E-Z isomerism resulting from double bonds, Oximes, Racemic mixtures and Racemization, Resolution of racemic mixtures, Optical purity & Enantiomeric excess, Formation of diasteromers, Stereoselective and stereospecific reactions, Stereoisomerism without a stereogenic carbon (axial chirality), Planar chirality, Helicity and Molecular stereoisomerism.

Unit 2. Prochirality and Asymmetric Synthesis (6 Hrs.)

Introduction, Homotopic & Heterotopic ligands and faces, Enantiotopic ligands & faces, Asymmetric synthesis.

Unit 3. Conformational Analysis & Reactivity (8 Hrs.)

Restricted rotation around single bonds-confirmations of ethane & butane, Origin of conformational energy, Conformations and chemical reactivity of acyclic system, cycloalkane ring other than cyclohexane, Conformations of substituted cyclohexane, stereoisomerism in di-substituted cyclohexanes, effect of confirmations on reactivity-cyclic system, conformation of heterocycles, conformation of sugars (Fisher, Haworth and chair), Epimers, Anomers, Epimerization and Anomeric effect.

Unit 4. Stereochemistry of Substitution & Elimination Reactions (12 Hrs.)

- **Aliphatic Nucleophilic Substitution Reactions**: Introduction, stereochemistry of S_N1 & S_N2 reaction mechanism, The S_Ni mechanism, Mixed S_N1 & S_N2 reaction, ambient nucleophile, Regioselectivity, Neighbouring group participation.

- **Stereochemistry of Elimination Reactions:** Introduction, Mechanism E^1, E^2 and E^1cB, Stereochemistry of E^2-anti-ellimination reaction, E^2-syn-elimination, Orientation of the double bond, Pyrolytic elimination.

Unit 5. Stereochemistry of Addition Reactions to Carbon-Hetero multiple bonds (8 Hrs.)

Introduction, Stereo chemical aspects of addition to carbonyl compounds, Stereochemistry of metal hydride reduction, Cannizzaro reaction, Meerwein-ponndorf reduction, Addition of organometallic compounds, Conjugate addition of organocopper reagents.

Reference Books

1. Stereochemistry -Conformation and mechanism- P.S.Kalsi.
2. Organic chemistry - I.L. Finar
3. Stereochemistry - D. Nasipuri
4. Organic Chemistry-J.Clayden
5. Stereochemistry-Eliel
6. Stereochemistry of organic compounds - P.S. Kalsi.
7. Stereoselective synthesis : A practical approach, - M. Nogradi, VCH

SEMESTER III

16PCHCC14	Core 12: Computer Based Test (CBT)	-	1 Credits

- An objective computer based test covering syllabus of SEM-I to III.

SEMESTER III

16PCHDC01	DSE -Core-1: Separation Techniques	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand and classify chromatography
- Elaborate & Illustrate Principle, Basic theory, Instrumentation, Techniques & Applications of modern chromatography
- Describe factors affecting chromatography

Unit 1. Adsorption & Partition Chromatography (10 Hrs.)

Classification, definition of terms; principle, basic theory, technique & applications.

Unit 2. Column Chromatography (8 Hrs.)

Principle, basic theory, technique & applications of: Column, ion-exchange and affinity chromatography.

Unit 3. Planar Chromatography (10 Hrs.)

Principle, basic theory, technique & applications of: Paper chromatography: AC, DC, CC, 2D-AC.

Thin layer chromatography: TLC, 2D-TLC & HP-TLC.

Unit 4. Gas Chromatography (10 Hrs.)

Instrumentation, working and applications of GC & GC-MS.

Unit 5. Liquid Chromatography (10 Hrs.)

Instrumentation, working and applications of HPLC & LC-MS.

Band broadening & Column efficiency: Definition of terms, factors affecting, plate theory & rate theory of chromatography, limitations of theory.

Reference Books

1. Thin layer chromatography, E. Stahl.
2. Chromatography, Heptman.
3. HPTLC, Dr. P. D. Sethi.
4. High Performance liquid chromatography, Dr. P.D. Sethi
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
7. Principles of Instrumental analysis, D.A. Skoog and W.B. Saunders.

SEMESTER III

16PCHDC02	DSE -Core-1: Technologies in Chemical Industries	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand Resources and need for membrane technology in water treatment in other process industrial plants.
- Promote interests of the pesticide manufacture & formulators engaged in all sectors of agro industries.
- Understand the principles of nanotechnology; characterization of nanostructured materials; and tools and equipment for producing and assembling at the nano scale.

Unit 1. Membrane Technology –I: (10 Hrs.)

Introduction of membrane technology, classification of membranes and membrane processes, basic operating principles and applications of various membrane processes – micro filtration, ultra filtration, nanofiltration, reverse osmosis, dialysis.

Unit 2. Membrane Technology –II: (10 Hrs.)

Classification of membranes and membrane processes, basic operating principles and applications of various membrane processes –membrane distillation, pervaporation, gas permeation, liquid membranes.

Unit 3. Introduction to Nanotechnology: (10 Hrs.)

Introduction, physical methods of synthesis of nanomaterials, mechanical & vapor deposition, chemical methods of synthesis of nanomaterials, colloids & colliding solutions, synthesis of colloids, synthesis of metal nanoparticles, properties and applications.

Unit 4. Industrial Formulations: (10 Hrs.)

Study of agrochemical industries with respect to their classification, raw materials, manufacturing process of at least four products of each class with special emphasis on chemistry and manufacturing principles:

- Insecticides.
- Pesticides.
- Fungicides.
- Weedicides.

Unit 5. Fermentation Technologies: (08 Hrs.)

Process calculations and stoichiometry. Metabolic engineering, transport in reactors. Design & working of bioreactor. Types of reactors, sterilization, utilities: Steam air water, specific industrial process involving microbes. Industrial production processes of various biochemical.

Reference Books

1. Nath, Kaushik. 2008. Membrane Separation Processes. New Delhi: Prentice Hall India Ltd.
2. C. Poole, F. Owens, 2009. Introduction to Nanotechnology, Panama: John Wiley and Sons
3. Strathmann, H. 2004. Ion-Exchange Membrane Separation Processes, Volume-9: Amsterdam, Elesveir Science.
4. Cardew PT & Le MS, 1998. Membrane Processes: A Technology Guide. London, Royal Soc. of Chemistry.

SEMESTER III

16PCHCC15	**Core Practical -3:** Pharmaceutical Technology, Medicinal Chemistry & Viva Voce	**10 hrs./Wk**	**5 Credits**

Objectives:

At the successful completion of the course, students will be able to:

- Prepare tablets, capsules, syrup and their evaluation
- Plan & perform synthesis of privilege scaffolds, pharmaceutically important molecules using green chemistry approach.
- Isolate, Purify and identify products using physical & spectroscopic techniques.
- Measure & correlate the physicochemical properties of chemicals/materials using various instrumentation techniques.

1. Pharmaceutical Technology:

1) **Preparation and evaluation** of effervescent tablet, ferrous sulphate tablet, Paracetamol tablet.
2) Preparation and evaluation of tablets employing direct compression, wet granulation, dry granulation (slugging), compression coating.
3) **Filling** of powder/ granules/ pellets in hard gelatin capsule and its evaluation.
4) Perform **pharmacopoeial test** for given sample of glass vial / ampoule.
5) Preparation and evaluation of face powder, lipstick, cold cream, vanishing cream, tooth paste/ tooth powder.
6) **Formulation and evaluation** of syrup, emulsion (o/w, w/o), turpentine liniment, calamine lotion.
7) Formulation and evaluation of milk of magnesia/aluminum hydroxide gel antacid suspension.
8) Formulation and evaluation of dry suspension.
9) Formulation and evaluation of diclofenac sodium gel.
10) Formulation and evaluation of transdermal spray.
11) Formulation and evaluation of calcium gluconate injection, dextrose injection, NaCl injection, dextrose saline injection, menadion injection.
12) Formulation and evaluation of eye drops.
13) Formulation and evaluation of multidose injection of chloroquine phosphate.
14) Formulation and evaluation of metronidazole infusion.

2. Medicinal Chemistry:

Synthesis of privileged scaffolds using Conventional & Green synthetic methods: Single / Multi-step synthesis of organic compounds, TLC monitoring & spectral study.

Green methods such as Microwave / Mortar pastel / Ionic Liquid / Water mediated / Solid support.

SEMESTER III

16PCHDC03	**DSE -Core-1 Practical:** Separation Techniques & Viva Voce	**2 hrs./Wk**	**1 Credits**

- **Analytical Techniques**:
  Chromatography: TLC, Column, Paper chromatography

SEMESTER III

16PCHDC04	**DSE -Core-1 Practical:** Technologies in Chemical Industries & Viva Voce	**2 hrs./Wk**	**1 Credits**

- Technologies in Chemical Industries

SEMESTER III

-	Dissertation	**1 hrs./Wk**	-

Dissertation

All the student of M.Sc. will undertake a research Project (Dissertation) in a group of 2-4 on full-time basis during semester-III & IV. The candidates will be given the option of selecting a research problem in a preferred area that falls within the disciplines of courses undertaken.

- At the end of the semester the candidates are required to present their results in the form of a Project thesis/Report & oral presentation.
- The evaluation (Presentation & Viva) of the Project work (Dissertation) will be carried out at the end of Sem-IV.

- **SEMESTER III**

16PCHCE03	Pilot Plant Operation	1 hrs./Wk	1 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Calibrate and operate various components of glass pilot plant
- Create SOPs for operation, maintenance & safety
- Plan & produce industrial products
- Plan & purify chemicals / solvents

Introduction of Pilot plant (Glass), Operational Procedure and training from the following:

- Components & Its Significance **(02 Hrs.)**
- SOP, Maintenance & Safety **(02 Hrs.)**
- Pilot scale Synthesis/ Purification/ Separation **(04 Hrs.)**
- Various Distillations **(04 Hrs.)**

SEMESTER IV

16PCHCC16	Core 13: Heterocyclic Chemistry	5 hrs./Wk	5 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Establish IUPAC nomenclature for heterocycles
- Predict and describe reactivity of heterocycles
- Illustrate & Plan synthetic methods for various heterocycles

Unit 1. **1. Nomenclature of Heterocyclic compounds.** **(12 Hrs.)**

2. Heterocyclic Analogues of Cyclopropane and Cyclobutane:

a. Preparation and properties of aziridine, oxirane, thiirane, Azetidine.

b. Preparation of 1,2-diazetidine, 1,2-dioxetane, 1,3-dithietane.

Unit 2. **Heterocyclic Analogues of Cyclopentane:** **(10 Hrs.)**

a. Preparation and properties of pyrrole, furan, thiophene.

b. Preparation and properties of indole, benzofuran, benzothiophene.

c. Preparation of isoindole, indolizine, isatin.

Unit 3. **1. Heterocyclic Analogues of Benzene:** **(10 Hrs.)**

Preparation and properties of pyridine and pyran.

2. Compounds with Two Heteroatoms in a Six Membered Ring:

Preparation of pyridazine, pyrimidine, pyrazine, thiazine, dioxane, morpholine, phthalazine, quinazoline, quinaxoline, phenothiazine.

Unit 4. **Heterocyclic Analogues of Naphthalene:** **(8 Hrs.)**

a. Preparation and properties of quinoline, isoquinoline, acridine.

b. Preparation of benzopyran, benzopyran-2-one and benzopyran-4-one.

Unit 5. **1. Compounds with two Heteroatoms in a Five Membered Ring:** **(8 Hrs.)**

a. Preparation & properties of pyrazole, oxazole, thiazole

b. Preparation of imidazole, isoxazole, isothiazole.

2. Compounds containing more than Two Heteroatoms:

Preparation of triazole, oxadiazole, thiadiazole, triazenes.

Reference Books

1. Heterocyclic Chemistry-R.K. Bansal
2. An introduction to the chemistry of Heterocyclic compds. - R.H.Acheson
3. Chemistry of Heterocyclic compounds-J.J. Trivedi
4. Heterocyclic Chemistry-R.R. Gupta, M.Kumar & V. Gupta, Springer
5. The chemistry of Heterocycles - T. Eicher & S. Hauptmann
6. Heterocyclic chemistry - J.A. Joule, K. Mills & G.F. Smith
7. Comprehensive Heterocyclic chemistry - A. R. Katritzky & C. W. Rees
8. Heterocyclic chemistry - T. L. Gilchrist

SEMESTER IV

16PCHCC17	Core 14: Medicinal Chemistry -II	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand and illustrate strategies for lead discovery & lead optimization
- Describe QSAR & predict descriptors
- Illustrate Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures for drugs.

Unit 1. Drug Design (10 Hrs.)

Introduction to drug design & development, strategies for new lead findings, pharmacophore, structure activity relationship (SAR), Lead modification including homologation, isosterism & bioisosterism, ring transformation and prodrug concept.

Unit 2. Quantitative Structure Activity Relationship (QSAR) (6 Hrs.)

History and development of QSAR, Physicochemical parameters: lipophilicity, electronic and steric. Study on Hansch LFER model, The Craig plot, the topliss scheme, Free Wilson analysis and mixed approach, CADD.

Unit 3. Synthetic Drugs (12 Hrs.)

Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR)* and synthetic procedures* of selected drugs of following.

Drugs acting on Cardiovascular System

- **Cardiotonic Agents**
  SAR: Cardiac glycosides
  Synthesis: Dobutamine,
- **Antihypertensive Agents**
  SAR: ACE Inhibitors, Dihydropyridnes
  Synthesis: Nifedipine, Atenolol, Captopril, Hydralazine.

- **Antiarrhythmic Agents,**
  Synthesis: Lignocaine, Flecainide.
- **Antianginal Agents,**
  Synthesis: Glyceryltrinitrate, Isosorbidedinitrate
- **Antihyperlipidemic agents,**
  SAR: HMG CoA Reductase inhibitors
  Synthesis: Clofibrate
- **Coagulants and Anticoagulants**

Synthesis: Warfarin

Unit 4. Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures of selected drugs of following. **(10 Hrs.)**

- **Diuretics**
  SAR: Thiazide diuretics
  Synthesis: Hydrochlorthiazide, Acetazolamide, Furosemide, Ethacrinic acid
- **Antidiabetic agents**
  Synthesis: Glipizide, Metformin, Pioglitazone, Tolbutamide, Glimipride.

Unit 5. Introduction, classification, mechanism of action, adverse effects, therapeutic uses, structure activity relationship (SAR) and synthetic procedures of selected drugs of following. **(10 Hrs.)**

- **Antiparkinson's agents,**
- **Alzheimer's disease,**
- **Non Steroidal Anti-Inflammatory Agents**
  Synthesis: Diclofenac, Ibuprofen, Indomethacin, Mefenamic acid, Nimesulide

Reference Books

1. Wilson and Gisvsld's Textbook of Organic Medicinal & Pharmaceutical Chemistry, Ed. Robert F. dorge.
2. The Organic Chemistry of drug design and drug action, R. B. Silverman.
3. Strategies for organic drug synthesis & design, D. Lednicer John Wiley.
4. Principles of Medicinal Chemistry, William O. Foye, Lippincott, William and Wilkins.
5. Total synthesis of Natural products, Apsimon (Series).
6. Textbook of Medicinal Chemistry by A. Kar, Asian Age. Publication.
7. Pharmaceutical substances by A. Kaleemann & Engle.

SEMESTER IV

16PCHCC18	**Core 15:** Dissertation	16 hrs./Wk	10 Credits

Dissertation

All the student of M.Sc. will undertake a research Project (Dissertation) in a group of 2-4 on full-time basis during semester-III & IV. The candidates will be given the option of selecting a research problem in a preferred area that falls within the disciplines of courses undertaken.

- Candidates have to present their research outcomes in the Pre presentation (Internal committee) before final Project thesis/Report & oral presentation.
- At the end of the semester the candidates are required to present their research outcomes in the form of a Project thesis/Report & oral presentation.
- The evaluation (Presentation & Viva) of the Project work (Dissertation) will be carried out at the end of Sem-IV.

SEMESTER IV

16PCHDC05	DSE -Core-2: Modern Analytical Techniques	4 hrs./Wk	4 Credits

Objectives:

At the successful completion of the course, students will be able to:

- Understand principal, basic theory, instrumentation techniques and application of spectroscopic methods
- Determine chemical structure from spectroscopic data analysis

Unit 1. Introduction to Spectroscopic Techniques: (08 Hrs.)

Types of analytical techniques, introduction of instrumental methods and its classification, overview of spectroscopic methods based on wave length regions of electromagnetic radiation, properties of electromagnetic radiation

Infrared Spectroscopy: Introduction to IR and FTIR, Principle & Theory of Infrared absorption spectrometry, Infrared sources and transducers, Sample handling, Instrumentation, Interpretation of IR spectra, Applications and limitations of IR spectroscopy.

Unit 2. Mass Spectroscopy: (08 Hrs.)

Introduction, principle, theory and components of mass spectrometers, different ionization and detection techniques, recording and resolution of mass spectrometer, types of ions produced in mass spectrometer, interpretation of Mass spectra of selected compounds/API, Applications of Mass spectrometry, Introduction to ICP-MS.

Unit 3. Emission Spectroscopy: (10 Hrs.)

Atomic emission spectroscopy, principle, theory and instrumentation, atomization techniques, Flame atomizer, Electrothermal atomizer and Inductively coupled plasma atomizer (ICPA).

Flame emission spectroscopy: Principle, Instrumentation and applications, Fluorimetry: Principle, instrumentation and application.

Unit 4. Nuclear Magnetic Resonance Spectroscopy: (14 Hrs.)

Introduction, NMR active nuclei, basic theory, NMR spectrometer, internal standard & solvent

^{1}H NMR (PNR): Principle, chemical shift, magnetic anisotropy, spin-spin coupling (multiplicity), applications & problems of nuclear magnetic resonance spectroscopy.

^{13}C NMR: Introduction, principle, chemical shift, application and problems of ^{13}C – NMR, Introduction to 2D NMR.

Structure Elucidation: Structure determination and distinction of various isomeric compounds through spectroscopic techniques (UV, IR, Mass & NMR)**.**

Unit 5. Polarimetry and Spectropolarimetry: (08 Hrs.)

Introduction, polarized light, optical activity, specific rotation measurement of rotatory power, optical rotatory dispersion and circulardichroism, Instrumentation and applications, Saccharimetry.

Reference Books

1. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
2. Spectrometric identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
4. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
5. Spectroscopy Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.
6. Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International Ltd.

SEMESTER IV

16PCHDC06	DSE -Core-2: Chemical Reaction Engineering	4 hrs./Wk	4 Credits

Objectives:

To enable the students to

- Describe Factors affecting reactor designing, Molecularity and order of reactions.
- Understand Design of Reactors, Kinetics of Heterogeneous Reactions. Determination of Surface area, porosity, density and particle size of catalyst.

Unit 1. **Fundamentals of Reaction Engineering:** Factors affecting reactor designing, Single and multiple Reactions, Elementary and Non-elementary reactions, Catalyzed and non-catalyzed reactions.

Unit 2. **Kinetics of Homogeneous Reactions:** Molecularity and order of reactions, Kinetic Models for non-elementary reactions, Temperature dependency and reaction rate prediction from Arrhenius, transition and collision theories.

Unit 3. **Design of Reactors:** Design of ideal batch, CSTR and Plug Flow Reactors and Residence Time Distribution.

Unit 4. **Kinetics of Heterogeneous Reactions:** Effect of transport processes on selectivity in series and parallel reactions, Rate equation for surface reactions, Determination of Surface area, porosity, density and particle size of catalyst.

Reference Books

1. Kundu, N., Jain, S. K. (1996) *Physical Chemistry*. New Delhi: S. Chand and Company.
2. Pandey, G. N., Srivastava, S. N. (1982) *Reaction engineering through solved problems*. New Delhi: Metropolitan Book.
3. Levenspiel, Octave (1998, Third edition) Chemical Reaction Engineering. Weinheim: John Wiley & Sons Ltd. (ISBN: 047125424X).
4. Smith, J. M. (1981, Third edition) *Chemical Engineering Kinetics*. New York: McGraw-Hill International. (ISBN: 0070665745).
5. Holland, Charles D., Anthony, Rayford G. (1988, Second edition) *Fundamentals of Chemical Reaction Engineering*. Upper Saddle River: Prentice Hall. (ISBN: 0133356396).

Denbigh, K. G. Turner, J. C. R. (1984, Third edition) *Chemical Reactor Theory: An Introduction*. Cambridge: Cambridge University Press. (ISBN: 0521276306).

SEMESTER IV

16PCHCE04	Instrumental Training	1 hrs./Wk	1 Credits

Instrumental Hands-on/Demonstrative training of the following:

- UV-Viz.
- IR
- GC-MS
- HPLC
- Flash chromatography
- KaFi Auto Titrator
- Microwave Synthesizer
- Lyophilizer
- H-Cube Mini Hydrogenator
- Radleys Parallel Synthesizer
- Ultrasonic bath