



**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. Chemistry**

**(With Specialization in Organic /Analytical Chemistry)**

## **PROGRAM OBJECTIVES:**

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

- To impart education at advanced level in a more holistic way and to enthuse the students for the subject.
- To provide flexibility in teaching & learning endowed with space for slow & fast learners.
- To update the students about the current status and new developments in the field of Chemistry.
- To train the students to make them confident and capable of accepting new challenges and Job roles in the field of chemistry.
- To expose the students to research in Chemistry and to promote the students for an independent research career.
- To make the students aware of the impact of Chemistry on health & environment and to enable them to imbibe the concept of sustainable development.
- 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	
<b>Part - I</b>							
16PCECC01	<b>Core 1:</b> Inorganic Chemistry	4	3	30	70	100	4
16PCECC02	<b>Core 2:</b> Organic Chemistry	4	3	30	70	100	4
16PCECC03	<b>Core 3:</b> Physical Chemistry	4	3	30	70	100	4
16PCECC04	<b>Core 4:</b> Analytical Chemistry	4	3	30	70	100	4
16PCECC05	<b>Core Practical -1:</b> Inorganic, Organic, Physical, Analytical Chemistry Practical	12	12	80	120	200	6
<b>Part - II</b>							
16PCECE01	IT Tools for Chemist	1	1	50	-	50	1
		<b>29</b>				<b>650</b>	<b>23</b>
<b>Part - III</b>							
16PVE01	Value Education	1	-	Remarks			1
		<b>30</b>				<b>650</b>	<b>24</b>

Semester-II							
Part - I							
16PCECC06	<b>Core 5:</b> Separation Techniques	5	3	30	70	100	5
16PCECC07	<b>Core 6:</b> Stereochemistry	4	3	30	70	100	4
16PCECC08	<b>Core 7:</b> Interpretative molecular spectroscopy <b>(Self Study course)</b>	1	-	30	70	100	4
16PCECC09	<b>Core 8:</b> Modern Analytical Techniques	4	3	30	70	100	4
16PCECC10	<b>Core Practical -2:</b> Separation Techniques, Stereochemistry, Modern Analytical Techniques Practical	15	12	80	120	200	6
Part - II							
16PCECE02	Scientific Writing (Research)	1	-	50	-	50	1
		<b>30</b>				<b>650</b>	<b>24</b>

\* After successful completion of Semester -I & Semester -II, option for student to select one of the Sub disciplines viz., Organic Chemistry **OR** Analytical Chemistry in Semester - III & Semester -IV.

Semester-III (SPECIALIZATION IN ORGANIC CHEMISTRY)							
Part - I							
16PCEOC01	<b>Core 9:</b> Organic Reactions, Rearrangements & Reagents	4	3	30	70	100	4
16PCEOC02	<b>Core 10:</b> Fundamentals of Medicinal Chemistry	4	3	30	70	100	4
16PCEOC03	<b>Core 11:</b> Chemistry of Natural Products	4	3	30	70	100	4
16PCEOC04	<b>Core 12:</b> Computer Based Test	-	-	50	-	50	1
16PCEOD01/ 16PCEOD02	<b>DSE – Core -1:</b> Polymer & Composite Materials <b>OR</b> Industrial Formulation Development	4	3	30	70	100	4
16PCEOC05	<b>Core Practical -3:</b> Organic Preparations	10	9	60	90	150	5
16PCEOD03/ 16PCEOD04	<b>DSE – Core -1 Practical:</b> Polymer & Composite Materials <b>OR</b> Industrial Formulations	2	3	20	30	50	1
-	Dissertation	1	-	Evaluated at the end of Sem-IV		-	-
Part - II							
16PCECE03	Pilot Plant Operation	1	-	50	-	50	1
		<b>30</b>				<b>700</b>	<b>24</b>

<b>Semester-IV (SPECIALIZATION IN ORGANIC CHEMISTRY)</b>							
<b>Part - I</b>							
16PCEOC06	<b>Core 13:</b> Chemistry of Synthetic Drugs	5	3	30	70	100	5
16PCEOC07	<b>Core 14:</b> Heterocyclic Chemistry	4	3	30	70	100	4
16PCEOC08	<b>Core 15:</b> Dissertation <b>OR</b> Practical	16	-	60	90	150	10
16PCEOD05/ 16PCEOD06	<b>DSE – Core -2:</b> Organic Synthesis: A Disconnection Approach <b>OR</b> Industrial Unit Processes	4	3	30	70	100	4
<b>Part - II</b>							
16PCECE04	Instrumental Training	1	-	50	-	50	1
		<b>30</b>				<b>500</b>	<b>24</b>
	<b>TOTAL</b>					<b>2500</b>	<b>96</b>

<b>Semester-III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)</b>							
<b>Part – I</b>							
16PCEAC01	<b>Core 9:</b> Industrial Formulation Development	4	3	30	70	100	4
16PCEAC02	<b>Core 10:</b> Electro Analytical Techniques	4	3	30	70	100	4
16PCEAC03	<b>Core 11:</b> Industrial Analysis	4	3	30	70	100	4
16PCEAC04	<b>Core 12:</b> Computer Based Test	-	-	50	-	50	1
16PCEAD01/ 16PCEAD02	<b>DSE – Core -1:</b> Chemistry of Food Analysis <b>OR</b> Environmental & Green Chemistry	4	3	30	70	100	4
16PCEAC05	<b>Core Practical -3:</b> Analysis of Industrial Products	10	9	60	90	150	5
16PCEAD03/ 16PCEAD04	<b>DSE – Core -1 Practical:</b> Chemistry of Food Analysis <b>OR</b> Environmental & Green Chemistry	2	3	20	30	50	1
-	Dissertation	1	-	Evaluated at the end of Sem-IV			-
<b>Part - II</b>							
16PCECE03	Pilot Plant Operation	1	-	50	-	50	1
<b>Total</b>		<b>30</b>				<b>700</b>	<b>24</b>

<b>Semester-IV (SPECIALIZATION IN ANALYTICAL CHEMISTRY)</b>							
<b>Part – I</b>							
16PCEAC06	<b>Core 13:</b> Regulatory Affairs & IPR	5	3	30	70	100	5
16PCEAC07	<b>Core 14:</b> Analytical Method Development, Validation & Stability Studies	4	3	30	70	100	4
16PCEAC08	<b>Core 15:</b> Dissertation <b>OR</b> Practical	16	-	60	90	150	10
16PCEAD05/ 16PCEAD06	<b>DSE – Core -2:</b> Selected Techniques in Analytical Chemistry <b>OR</b> Phytopharmaceutical Analysis	4	3	30	70	100	4
<b>Part - II</b>							
16PCECE04	Instrumental Training	1	-	50	-	50	1
		<b>30</b>				<b>500</b>	<b>24</b>
	<b>TOTAL</b>					<b>2500</b>	<b>96</b>



### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOC01	Core 9: Organic Reactions, Rearrangements & Reagents	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Understand concept and types of reaction mechanism draw arrow notation, categorize bond cleavages,
- Determine the stability of reactive intermediates applying concepts of inductive, resonance & mesomeric effect.
- Write Principle, describe plausible reaction mechanism and list applications of various organic named reactions.
- Understand concept of molecular rearrangement and Describe plausible reaction mechanism mentioning its applications in organic synthesis.
- Understand preparation, chemical and physical properties and applications of reagents useful in organic transformations
- Identify suitable starting material, reagent and reaction condition or product for given organic transformations.

#### Unit 1. Reaction based on Reactive Intermediates-1: (8 Hrs.)

Principal, mechanism and applications:

- **Carbocation:** Beckmann, Pinacol-pinacolone, Demjanov Rearrangement
- **Carbanion:** Aldol condensation, Perkin reaction, Dieckmann Condensation, Benzilic acid rearrangement, Michael addition, Grignard reaction
- **Free radical:** Sandmeyer, Wurtz-Fittig, Hunsdiecker reaction,

#### Unit 2. Reaction based on Reactive Intermediates-2: (10 Hrs.)

Principal, mechanism and applications:

- **Carbene:** Wolf rearrangements, Riemer-Tiemann reaction
- **Nitrene:** Hoffmann, Curtius, Schmidt Rearrangement
- **Ylides, Enamines and Dithio ketene acetal:** Wittig, Stork enamine, Junjappa-Ila reaction
- **Homologation:** Arndt-Eistert, Corey-Fuchs alkyne synthesis

#### Unit 3. Reaction based on Cyclization: (10 Hrs.)

Principal, mechanism and applications:

- **Carbocyclic formation:** Robinson annulation, Danishefsky's diene cycloaddition
- **Heterocyclic formation:** Fischer indole, Hantzsch dihydropyridine, Knorr pyrrole, Von Pechman reaction.
- **Pericyclic and metathesis:** Diels alder cycloaddition, Hetero Diels alder, Aza-Cope rearrangement, Claisen rearrangement, alkene and alkyne metathesis.

**Unit 4. Multicomponent & Cross coupling Reactions: (10 Hrs.)**

Principal, mechanism and applications:

- **Multicomponent reaction:** Ugi, Biginelli, Mannich reaction
- **Pd-catalyzed cross coupling reaction:** Suzuki, Sonogashira, Heck, Negashi, Kumada, Stille, Buchwald-Hartwig reaction

**Unit 5. Important Reagents: (10 Hrs.)**

Structure, properties, synthesis and applications:

(1) DDQ, (2) Dicyclohexylcarbodiimide (DCC), (3) Diethyl azodicarboxylate (DEAD), (4) Lithium diisopropylamide (LDA), (5) LiAlH<sub>4</sub> (LAH) (6) *m*-Chloroperbenzoic acid (MCPBA), (7) *N*-Bromosuccinimide (NBS), (8) Triphenylphosphene (TPP), (9) Aluminium isopropoxide (Al(*O-i*-Pr)<sub>3</sub>), (10) *n*-Butyllithium (*n*-BuLi), (11) Osmium Tetroxide (OsO<sub>4</sub>), (12) TBAB (Quaternary Ammonium salt).

**Reference Books**

1. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. László Kürtip; Barbara Czako (2004, First edition) *Strategic Applications of Named Reaction in Organic Synthesis*. Philadelphia: Elsevier Publishing company (ISBN: 9780124297852).
3. Organic Chemistry (VI edition) - R.T Morrison- Boyd. Prentice Hall of India (2003)
4. Organic Chemistry- (V edition) - John McMurry), Asian Book Pvt Ltd, New Delhi
5. Advanced organic chemistry (IV edition) - Jerry March
6. A text book of Organic Chemistry, - Raj K. Bansal, New Age International (P) Ltd. 4th Edition 2003
7. Organic Chemistry, T.W. Graham Solomon, Craig B. Fryble, Low Price 8th Edition, John Wiley & Sons, Inc.

### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOC02	Core 10: Fundamentals of Medicinal Chemistry	4 hrs./Wk	4 Credits
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#### 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 pharmacokinetics 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. Drugs discovery (10 Hrs.)

History and development of medicinal chemistry, drugs and their important, drug discovery, lead discovery, lead discovery from natural sources, lead discovery through random screening, nonrandom (or targeted or focused) screening, drug metabolism studies, clinical observations, rational approaches to lead discovery.

#### Unit 2. Lead Modification: Drug Design and Development (12 Hrs.)

Identification of the Active Part: the pharmacophore, functional group modification. structure–activity relationships, privileged structures and drug-like molecules. Structure modifications to increase potency and the therapeutic index: Homologation, chain branching, ring-chain transformations, bioisosterism. Clinical Studies: Phase 1, 2, & 3 clinical trials, evaluations, post clinical trials, filing of NDA.

**QSAR:** Introduction to quantitative structure–activity relationships (QSARs), lipophilicity, partition coefficients (P), lipophilic substitution constants (p), electronic effects, The Hammett constant (s), steric effects, The Taft steric parameter (Es), molar refractivity (MR), other parameters. Hansch analysis, Craig plots, The Topliss decision tree.

#### Unit 3. Pharmacokinetics and Pharmacodynamics: (12 Hrs.)

Introduction, route of drug absorption, distributions of the drug and factor affecting. Receptors and Drug action: Types of receptors, theories of drug-receptor interactions, biotransformation of the drug, phase I & II reactions. Concept of drug excretion, study of LD<sub>50</sub>, ED<sub>50</sub>, MIC and EC<sub>50</sub>, GI<sub>50</sub> etc.

#### Unit 4. Prodrug (08 Hrs.)

Concept, structure and classification of prodrug, Use of Prodrugs: masking taste or odour, minimizing pain at site of injection, alteration of drug solubility, overcome absorption problems, prevention of pre-systemic metabolism, longer duration of action diminish local and systemic toxicity.

**Unit 5. Combinatorial Chemistry:****(06 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 (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOC03	Core 11: Chemistry of Natural Products	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Importance and classification of steroid, constitution of important steroid & hormones, chemistry of selected steroid and hormones.
- Classification synthesis and importance of selected vitamins & alkaloids.
- Structure & function of amino acids, automated peptide synthesis.
- Importance and synthesis of DNA building blocks; purines, pyrimidines & nucleic acid.
- Occurrence, pharmaceutical activity and total synthesis selected natural products.

#### Unit 1. Steroids: (10 Hrs.)

Introduction, classification of sterol, Constitution of cholesterol,

- Bile acid: Introduction, Synthesis of 5 $\alpha$ - and 5 $\beta$ -Cholanic acid,
- Steroid Hormones: Introduction, type, synthesis of Androsterone, Testosterone, Oestrone, Oestradiol, Oestriol, Progesterone.
- Adrenocortical hormones: Introduction, synthesis of Aldosterone.

#### Unit 2. Vitamins: (09 Hrs.)

Introduction, classification and importance including hyper/hypo diseases. Synthesis of Vitamin A, B (folic acid, niacin, pantothenic acid, riboflavin-B<sub>2</sub>, pyridoxine-B<sub>6</sub>), C and E (alpha and beta tocopherols and tocotrienols)

#### Unit 3. Alkaloids: (10 Hrs.)

Introduction, definition, classification, extraction and phytochemical test

Synthesis and importance of following alkaloids:

- **Phenanthrene group:** Morphine, Heroin, Codeine
- **Indole group:** Reserpine
- **Quinoline group:** Quinine
- **Pyridine groups:** Ricinine
- **Pyrolidine group:** Nicotine
- **Tropane alkaloids:** Atropine, Cocaine
- **Phenylethylamine:** Adrenaline

#### Unit 4. Purines, Pyrimidine and Nucleic acids: (10 Hrs.)

Introduction, importance and synthesis of:

- **Purines bases:** Uric acid, Purine, Adenine, Guanine
- **Xanthine bases:** Xanthine, Hypoxanthine, Caffeine, Theobromine, Theophylline
- **Pyrimidines:** Uracil, Thymine and Cytosine

**Nucleic acids:** Introduction, structure of nucleic acid, structure difference between DNA & RNA. Synthesis of Nucleosides and Nucleotides

**Unit 5. Total Synthesis of Selected Natural Products: (09 Hrs.)**

Pharmaceutical Activity and Occurrence thereof: 7-Methylomuralide, Agelastatin A, (-)Bursehemin, Carpanone, Chelidonine, Fulvoplumierin, Griseofulvin, Janoxepin, Luotonin A, (-)Mersicarpine, Taxol, (+)Vinblastine.

**Reference Books**

1. Finar, I.L. (1989, Fifth edition) *Organic Chemistry: Vol -2: Stereochemistry and the Chemistry of Natural Products*. Harlow: Longman. (ISBN: 0-582-05916-X).
2. Mann, J.; Harborne, J.; Davidson R. S. (1994) *Natural Products: Their Chemistry and Biological Significance*. Harlow: Longman Publishing Group. (ISBN: 0470200022).
3. Hostettmann, Kurt; Gupta, M. P.; Marston A. (1994) *Chemistry, Biological & Pharmacological properties of medicinal plants from the Americas*. Newark: Harwood Academic Publishers. (ISBN: 9057023970).
4. Norman, R. O. C.; Coxon, J. M. (1993, Third edition) *Principles of organic synthesis*. New Delhi: CBS Publishers & Distributors. (ISBN: 0748761624).
5. Carey, F. A.; Sundberg, R. J. (2010, Fifth edition) *Advanced Organic Chemistry Part B: Reactions and Synthesis*. Berlin: Springer. (ISBN: 0387683542).
6. Nogradi, M. (2008, Second revised and updated edition) *Stereoselective synthesis: A practical approach*. Weinheim: Wiley VCH. (ISBN: 978-3-527-61568-1).

**SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)**

16PCEOC04	Core 12: Computer Based Test	-	1 Credits
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- An objective computer based test covering syllabus of SEM-I to III.

### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOD01	DSE – Core -1: Polymer & Composite Materials	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Discuss various reactions of polymers.
- Describe the different methods of moulding used for polymer.
- Elaborate processing technology for plastic, rubber and composites.

#### Unit 1. Introduction to polymer reactions: (08 Hrs.)

Hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reaction, reaction of various specific groups, cyclization reaction, cross linking reaction, reactions leading to graft and block copolymers, miscellaneous reactions

#### Unit 2. Polymer processing techniques: (12 Hrs.)

Introduction, plastic, elastomers fibers, compounding.

Processing techniques: (1) calendaring (2) die-casting (3) rotational casting (4) film casting (5) injection moulding (6) compression moulding (7) blow moulding (8) extrusion moulding (9) thermo forming (10) foaming, reinforced plastic. Reinforced plastic, reinforcing techniques: (1) hand lay - up (2) filament - winding (3) spray -up techniques. Other techniques: fiber spinning.

#### Unit 3. Plastics materials and processing technology: (10 Hrs.)

Introduction, plastic polymer from linear low density poly ethylene, poly propylene, acrylic plastics, poly vinyl acetate, poly vinyl chloride, coumarone indene resins, poly acetate and polyether, poly imides, poly carbonates, epoxy resins, cellulose plastics, phenolic resins, amino resins, silicones, additives for plastics.

#### Unit 4. Rubbers materials and processing technology: (10 Hrs.)

Introduction, natural rubber, synthetic rubber, thermo plastic elastomers, rubber compounding and processing technology, sulfur vulcanization, non -sulfur vulcanization, assessment of processability and state of cure, hard rubber, ebonite, latex technology, some major rubber products.

#### Unit 5. Composite materials: (08 Hrs.)

Introduction and history, types of composites, physical properties of composite materials, testing of composite, example of composites. Application of composite: aircraft/military, transport, civil infrastructure, construction, consumer, corrosion resistance equipment, aerospace, electronic, marine, automobile and other application.

#### Reference Books

1. Textbook of polymer science-third edition by Fred.W. Billmeyer Jr., a Willey Inter-science publications, ISBN-9971-51-141-X.

2. Polymer Science by V. R. Govariker, New age international publisher, ISBN:978-0-85226-307-5.
3. Polymer science and technology of plastics and rubbers by Premamoy Ghosh, Tata McGraw-Hill publishing company ltd ISBN: 0-07-451648-5.
4. Composite material handbook-department of defence handbook.



### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOD02	DSE – Core -1: Industrial Formulation Development	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Describe the types and excipient of the tablet & Capsules.
- Discuss about various sterile dosage forms.
- Account of cosmetic products.
- Classify and understand formulations of agricultural formulations.

#### Unit 1. Solid Dosage Forms: (12 Hrs.)

- **Tablet** (a) Definition, Advantages and disadvantages, Introduction to types of tablets, formulation of different types of tablets; excipients, granulation techniques, Directly compressible excipients, machinery for large scale granulation and compression, physics of tablet making, compression and compaction, In process controls, processing problems and remedies, (b) Evaluation (Pharmacopoeial and nonpharmacopoeial test) and equipments. The Brief outline on manufacturing method and evaluation 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, specialized coating processes. (d) Pharmaceutical Tablet Compression Tooling: Terminology, tablet design, specification and information required, use and care of the tooling, problem solving.
- **Capsules** Hard Capsules: Definitions, advantages, disadvantages, Ideal requirements, Production of Hard capsules (Gelatin and nongelatin e.g. vegetable), Capsule storage, size of capsules, formulation and methods of capsule filling, problems and remedies, quality control, climatic control in capsule department, I.P capsules. Soft Gelatin Capsules: Formulation of shell and capsule coat, quality control with special emphasis on current dissolution testing.

#### Unit 2. Sterile Dosage Forms: (12 Hrs.)

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

Parenteral suspensions, Prefilled syringes, Parenteral nutrients, Freeze dried products, Nanosuspensions etc, I.P. Products. Ophthalmic preparations: Requirements, formulations, methods of preparations, containers and evaluation. I.P. Products

**Unit 3. Liquid and Semisolid Dosage Forms: (10 Hrs.)**

- **Liquid dosage forms:** Introduction, advantages and disadvantages, types of additives used-vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavors etc; manufacturing, packaging and evaluation of clear liquids, suspensions and emulsions ( including microemulsion and multiple emulsion) and brief outline of other liquid products such as extracts, tincture, infusion etc., I.P. Products.
- **Semisolid dosage forms:** Definition, Advantages and disadvantages, types, mechanisms of drug penetration through skin, factors influencing penetration, semisolid bases, their selection and ideal requirements of bases. General formulation of semisolids, clear gels, suppositories; Manufacturing procedure, evaluation and packaging. I.P. products.

**Unit 4. Cosmeticology and Cosmetic Preparations: (08 Hrs.)**

- Fundamentals of cosmetic science, structure and functions of skin and hair, 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, brief introduction to cosmeceuticals, baby care products, shaving cream, hygienic products

**Unit 5. Agricultural Formulations: (06 Hrs.)**

- Brief review on requirements of Agricultural formulations, Advantages and disadvantages of it Classification of Agricultural formulations, synthetic preparation and formulation of agrochemical products including pesticides, Herbicides, Weedicides and fertilizers.

**References Books**

1. The Theory and Practice of Industrial Pharmacy by L Lachman, H Lieberman and J Kanig.
2. 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
5. Pharmaceutical Dosage Forms: Disperse systems: Vol.1, Vol. 2 and Vol.3, Ed. by Lieberman, Leon Lachman and Joseph B. Schwartz, Marcel Dekker Inc., New York.

6. Pharmaceutical Dosage Forms: Parenteral Medication: Vol.1, Vol. 2 and Vol.3, Ed. by Lieberman, Leon Lachman and Joseph B. Schwartz, Marcel Dekker Inc., New York
7. GMP for Pharmaceuticals by S. H. Willig and J. R. Storker.
8. Cosmetics by Poucher
9. Latest editions of IP, BP, USP.

**SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)**

<b>16PCEOC05</b>	<b>Core Practical-3:</b> Organic Preparations & Viva Voce	<b>10 hrs./Wk</b>	<b>5 Credits</b>
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- **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 (SPECIALIZATION IN ORGANIC CHEMISTRY)**

<b>16PCEOD03</b>	<b>DSE –Core -1 Practical:</b> Polymer & Composite Materials & Viva Voce	<b>2 hrs./Wk</b>	<b>1 Credits</b>
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- **Practicals of Polymer & Composite Materials**
  - Preparation of various polymers
  - Preparation of various composites

### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

<b>16PCEOD04</b>	<b>DSE –Core -1 Practical:</b> Industrial Formulation Development & Viva Voce	<b>2 hrs./Wk</b>	<b>1 Credits</b>
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#### 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.

#### Industrial Formulation Development Practical

- 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) Preparation and evaluation of face powder, lipstick, cold cream, vanishing cream, tooth paste/ tooth powder.
- 5) **Formulation and evaluation** of syrup, emulsion (o/w, w/o), turpentine liniment, calamine lotion.
- 6) Formulation and evaluation of milk of magnesia/aluminum hydroxide gel antacid suspension.
- 7) Formulation and evaluation of dry suspension.
- 8) Formulation and evaluation of Diclofenac sodium gel.
- 9) Formulation and evaluation of eye drops.
- 10) Formulation and evaluation of Metronidazole infusion.

### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

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

40% of the students (on the basis of Merit/Test/Interview) admitted for the specialized course 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 will be carried out during practical examination of Sem-IV.

**SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)**

<b>16PCECE03</b>	<b>Pilot Plant Operation</b>	<b>1 hrs./Wk</b>	<b>1 Credits</b>
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**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 (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOC06	Core 13: Chemistry of Synthetic Drugs	5 hrs./Wk	5 Credits
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### Objectives:

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

- Understand and Describe classification & synthesis of anticancer, anti-infectious, cardiovascular and metabolic disorder drugs.
- Understand and illustrate classification & synthesis of CNS acting agents, anti-inflammatory drugs, and anesthetic agents.

### Unit 1. Cancer and Infectious Diseases (08 Hrs.)

Introduction to diseases, classification of anticancer and antiinfectious drugs, synthesis of the following classes of the drugs:

- (1) DNA alkylating agents and Aromatase Inhibitors: Anastrozole, Letrozole, Eramustine, Cisplatin.
- (2) Quinolone Antibiotics: Levofloxacin, Moxifloxacin.
- (3) Triazole Antifungals: Itraconazole, Fluconazole.
- (4) Non-Nucleoside HIV Reverse Transcriptase Inhibitors: Nevirapine, Delavirdine Mesylate
- (5) Neuraminidase Inhibitors For Influenza: Oseltamivir Phosphate (Tamiflu), Zanamivir.

#### Antimycobacterial Drugs

- (1) First-Line Drugs: Isoniazid, Ethambutol, Pyrazinamide.
- (2) Second-Line Drugs: Fluroquinolones (*e.g.*, ofloxacin, ciprofloxacin).

### Unit 2. Cardiovascular and Metabolic Diseases (08 Hrs.)

Introduction to diseases, classification of drugs acting on Cardiovascular and Metabolic, synthesis of the following classes of the drugs:

- (1) Type 2 Diabetes: Rosiglitazone, Pioglitazone.
- (2) Hypertension: Losartan Potassium, Irbesartan, Telmisartan.
- (3) Calcium Channel Blockers for Hypertension: Nifedipine, Amlodipine Besylate.
- (4) Second-Generation Hmg-Coa Reductase Inhibitors: Rosuvastatin, Atorvastatin.

#### Duretics

- (1) Thiazides(Benzothiadiazines): Chlorothiazide, Hydrochlorothiazide
- (2) Carbonic-Anhydrase Inhibitors: Acetazolamide, Ethoxzolamide
- (3) Miscellaneous Sulphonamide Diuretics: Indapamide
- (4) Purine or Xanthine Derivatives: Caffeine
- (5) Miscellaneous Diuretics- Triamterene



**Unit 3. Central Nervous System Diseases (04 Hrs.)**

Introduction to diseases, classification of drugs acting on Central Nervous System, synthesis of the following classes of the drugs:

- (1) Antidepressant: Venlafaxine, Duloxetine.
- (2) Insomnia: Zolpidem, Zaleplon, Indiplon.
- (3) Antiepileptic: Gabapentin.
- (4) Attention Deficit Hyperactivity Disorder: Amphetamine.

**Unit 4. Analgesic and Anti-Inflammatory Drugs (08 Hrs.)**

Introduction to diseases, classification of Analgesic and Anti-Inflammatory Drugs, synthesis of the following classes of the drugs:

**Non-Steroidal Anti-Inflammatory Drugs (NSAIDs):**

- (1) Heteroarylacetic acid analogues: Indomethacin, Sulindac, Tolmetin sodium.
- (2) Arylacetic acid analogues: Ibuprofen, Diclofenac sodium.
- (3) Arylpropionic acid analogues: Ketoprofen, Indoprofen.
- (4) Naphthalene acetic acid analogues: Naproxen.
- (5) Salicylic acid analogues: Aspirin, Benorilate.
- (6) Pyrazolones and pyrazolodiones: Phenazone (Antipyrine), Phenylbutazone.

**Antipyretic analgesics**

- (1) Aniline and p-Aminophenol Analogues: Paracetamol, Phenacetin.
- (2) Quinoline Derivatives: Cinchophen.
- (3) The N-Arylanthranilic Acids: Mefenamic Acid, Flufenamic Acid.

**Unit 5. Miscellaneous agents (08 Hrs.)**

Introduction to diseases, classification of Anesthetic & Antiparkinsonism, drugs, synthesis of the following classes of the drugs:

**General Anaesthetics:**

- (1) Inhalation Anaesthetics: Halothane, Chloroform.
- (2) Intravenous Anaesthetics: Ketamine Hydrochloride, Propofol.
- (3) Basal Anaesthetics: Tribromoethanol, Paraldehyde.

**Local Anesthetic**

- (1) The Esters: Benzocaine, Procaine Hydrochloride, Cyclomethycaine Sulphate
- (2) Piperidine or Tropane Derivatives:  $\alpha$ -Eucaine, Benzamine Hydrochloride.
- (3) The Amides: Lignocaine Hydrochloride, Prilocaine Hydrochloride, Doperdon.
- (4) The Quinoline and Iso-quinoline Analogues: Dibucaine Hydrochloride, Dimethisoquin Hydrochloride.
- (5) Miscellaneous Type: Phenacaine Hydrochloride, Pramoxine Hydrochloride.

**Antiparkinsonism Agents**

- (1) Piperidine analogues: Cyrimine hydrochloride, Trihexyphenidyl hydrochloride
- (2) Pyrrolidine analogues: Procyclidine Hydrochloride

- (3) Phenothiazine analogues: Ethopropazine Hydrochloride
- (4) Miscellaneous drugs: Dopamine, Orphenadrine citrate, Levodopa

#### **Reference Books**

1. The Art of Drug Synthesis by Douglas S. Johnson and Jie Jack Li, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN 978-0-471-75215-8.
2. Synthesis of Essential Drugs by R.S. Vardanyan and V.J. Hruby, Elsevier, ISBN: 978-0-444-52166-8.
3. Medicinal Chemistry by Ashutosh Kar, New Age International (P) Ltd, ISBN : 978-81-224-2305-7.
4. Burger's Medicinal chemistry and drug discovery, Sixth edition by Donald J. Abraham, John Wiley and Sons, Inc.

## SEMESTER IV (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOC07	Core 14: Heterocyclic Chemistry	4 hrs./Wk	4 Credits
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### 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-diazetidene, 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: (08 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: (08 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 (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOC08	Core 15: Dissertation OR Practical	16 hrs./Wk	10 Credits
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### Dissertation

40% of the students (on the basis of Merit/Test/Interview) admitted for the specialized course 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 will be carried out during practical examination of Sem-IV.

### Practical

- **Synthesis of privileged scaffolds using Conventional or 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.
- **Synthesis of following compounds:**  
Dyes & intermediate / Drugs & Intermediate / Agrochemicals / Polymer

## SEMESTER IV (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEOD05	DSE –Core -2: Organic Synthesis – A Disconnection Approach	4 hrs./Wk	4 Credits
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### Objectives:

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

- Understand concept of disconnection, synthon and synthetic equivalents and its application in disconnection analysis.
- Understand concept of functional group interconversion strategy and its application for the aromatic compounds.
- Recognize disconnection pattern for dicarbonyl compounds including 1-2,1-3, 1-4, 1-5 and 1-6 dicarbonyl framework and plan synthesis thereof.
- Design, evaluate and plan disconnection strategy & synthesis of targeted molecules.

### Unit 1. A Disconnection Approach: (10 Hrs.)

Introduction to disconnection, concept of synthon, synthetic equivalent, functional group inter-conversion, concept and design of synthesis, criteria of good disconnection

### Unit 2. One & Two Group Disconnection: (12 Hrs.)

Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives, Disconnections in 1,3-dioxygenated skeletons, preparation of 8-hydroxy carbonyl compounds,  $\alpha,\beta$ -unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5-dicarbonyls and use of Mannich Reaction

### Unit 3. Illogical Two Group Disconnections: (08 Hrs.)

Disconnection and synthesis of 2-hydroxy carbonyl compounds, 1,2-diols, 1,4 and 1,6-dicarbonyl compounds.

### Unit 4. Disconnection & Synthesis of Acyclic, Cyclic Hetero-Compounds: (08 Hrs.)

Synthesis of ethers, amines, nitrogen and oxygen containing 5 & 6 membered heterocycles

### Unit 5. Chemoselectivity & Protecting Groups: (10 Hrs.)

Introduction, three types of control, Chemoselectivity examples and rules, Chemoselectivity by (i) Reactivity (ii) Reagent, Examples of Chemoselectivity in Synthesis. Protection of organic functional groups, protecting reagents and removal of protecting groups.

### Reference Books

1. Warren, S.; Wyatt, P. (2008, Second edition) *Organic Synthesis: The Disconnection Approach*. Weinheim: Wiley. (ISBN: 978-0-470-71236-8).
2. Warren, S. (1978) *Designing Organic Syntheses: A Programmed Introduction to the Synthon Approach*. Weinheim: Wiley. (ISBN: 978-0-471-99612-5).

3. Carruthers, W.; Coldham, Iain (2004, Fourth Edition) *Modern Methods of Organic Synthesis*. Cambridge: Cambridge University Press. (ISBN: 9780521778305).
4. Fuhrhop, J. -H.; Li, Guangtao; Corey, E. J. (2003, Third completely revised and Enlarged edition) *Organic Synthesis: Concepts and Methods*. Weinheim: Wiley VCH. (ISBN: 978-3-527-30272-7).

**SEMESTER IV (SPECIALIZATION IN ORGANIC CHEMISTRY)**

<b>16PCEOD06</b>	<b>DSE –Core -2: Industrial Unit Processes</b>	<b>4 hrs./Wk</b>	<b>4 Credits</b>
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**Objectives:**

To enable the students to

- Describe Principle, Reagents, Mechanism, Kinetics and Applications of Halogenation, Alkylation & Acylation, Oxidation, Hydrogenation & Reduction, Nitration, Sulphonation and Esterification.

**Unit 1. Halogenation: (08 Hrs.)**

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing

**Unit 2. Alkylation & Acylation: (10 Hrs.)**

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing

**Unit 3. Oxidation, Hydrogenation & Reduction: (12 Hrs.)**

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing

**Unit 4. Nitration, Sulphonation: (10 Hrs.)**

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing

**Unit 5. Esterification: (08 Hrs.)**

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing

**Reference Books**

1. Groggins, P. H. (2001, Fifth edition) *Unit Processes in organic Synthesis*. New Delhi: Tata McGraw-Hill. (ISBN: 0-07-462143-2).
2. Matar, Sami; Hatch, Levis F. (2001, Second edition) *Chemistry of Petrochemicals Processes*. Houston: Gulf Professional Publishing. (ISBN: 0-88415-315-0).
3. Weissrermel, K.; Arpe, H. -J. (2008, Fourth edition) *Industrial organic Chemistry*, Hoboken: Wiley-VCH. (ISBN: 9783527305780).

**SEMESTER IV (SPECIALIZATION IN ORGANIC CHEMISTRY)**

<b>16PCECE04</b>	<b>Instrumental Training</b>	<b>1 hrs./Wk</b>	<b>1 Credits</b>
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**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



### SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAC01	<b>Core 9: Industrial Formulation Development</b>	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Describe the types and excipient of the tablet & Capsules.
- Discuss about various sterile dosage forms.
- Account of cosmetic products.
- Classify and understand formulations of agricultural formulations.

#### Unit 1. Solid Dosage Forms: (12 Hrs.)

- **Tablet** (a) Definition, Advantages and disadvantages, Introduction to types of tablets, formulation of different types of tablets; excipients, granulation techniques, Directly compressible excipients, machinery for large scale granulation and compression, physics of tablet making, compression and compaction, In process controls, processing problems and remedies, (b) Evaluation (Pharmacopoeial and nonpharmacopoeial test) and equipments. The Brief outline on manufacturing method and evaluation 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, specialized coating processes. (d) Pharmaceutical Tablet Compression Tooling: Terminology, tablet design, specification and information required, use and care of the tooling, problem solving.
- **Capsules** Hard Capsules: Definitions, advantages, disadvantages, Ideal requirements, Production of Hard capsules (Gelatin and nongelatin e.g. vegetable), Capsule storage, size of capsules, formulation and methods of capsule filling, problems and remedies, quality control, climatic control in capsule department, I.P capsules. Soft Gelatin Capsules: Formulation of shell and capsule coat, quality control with special emphasis on current dissolution testing.

#### Unit 2. Sterile Dosage Forms: (12 Hrs.)

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

Parenteral suspensions, Prefilled syringes, Parenteral nutrients, Freeze dried products, Nanosuspensions etc, I.P. Products. Ophthalmic preparations: Requirements, formulations, methods of preparations, containers and evaluation. I.P. Products

**Unit 3. Liquid and Semisolid Dosage Forms: (10 Hrs.)**

- **Liquid dosage forms:** Introduction, advantages and disadvantages, types of additives used-vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavors etc; manufacturing, packaging and evaluation of clear liquids, suspensions and emulsions (including microemulsion and multiple emulsion) and brief outline of other liquid products such as extracts, tincture, infusion etc., I.P. Products.
- **Semisolid dosage forms:** Definition, Advantages and disadvantages, types, mechanisms of drug penetration through skin, factors influencing penetration, semisolid bases, their selection and ideal requirements of bases. General formulation of semisolids, clear gels, suppositories; Manufacturing procedure, evaluation and packaging. I.P. products.

**Unit 4. Cosmeticology and Cosmetic Preparations: (08 Hrs.)**

- Fundamentals of cosmetic science, structure and functions of skin and hair, 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, brief introduction to cosmeceuticals, baby care products, shaving cream, hygienic products

**Unit 5. Agricultural Formulations: (06 Hrs.)**

- Brief review on requirements of Agricultural formulations, Advantages and disadvantages of it Classification of Agricultural formulations, synthetic preparation and formulation of agrochemical products including pesticides, Herbicides, Weedicides and fertilizers.

**References Books**

1. The Theory and Practice of Industrial Pharmacy by L Lachman, H Lieberman and J Kanig.
2. 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
5. Pharmaceutical Dosage Forms: Disperse systems: Vol.1, Vol. 2 and Vol.3, Ed. by Lieberman, Leon Lachman and Joseph B. Schwartz, Marcel Dekker Inc., New York.

6. Pharmaceutical Dosage Forms: Parenteral Medication: Vol.1, Vol. 2 and Vol.3, Ed. by Lieberman, Leon Lachman and Joseph B. Schwartz, Marcel Dekker Inc., New York
7. GMP for Pharmaceuticals by S. H. Willig and J. R. Storker.
8. Cosmetics by Poucher
9. Latest editions of IP, BP, USP.

### SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAC02	Core 10: Electro Analytical Techniques	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Understand, Explain, and differentiate the instrumentation and applications of Potentiometry, Coulometry, Voltammetry, Polarometry and Amperometry.

Introduction, principle, Basic scientific theory, instrumentation and applications of following:

<b>Unit 1.</b> Potentiometry	<b>(10 Hrs.)</b>
<b>Unit 2.</b> Coulometry	<b>(10 Hrs.)</b>
<b>Unit 3.</b> Voltammetry	<b>(10 Hrs.)</b>
<b>Unit 4.</b> Polarometry	<b>(10 Hrs.)</b>
<b>Unit 5.</b> Amperometry	<b>(08 Hrs.)</b>

#### Reference books

1. Fundamentals of Analytical Chemistry – Skoog, Harcourt College Publishers.
2. Quantitative chemical analysis – Vogel A. I., Pearson Education.
3. Text Book of Pharmaceutical Analysis – K. A. Connor, John Willey & Sons, New York.
4. Quantitative Chemical Analysis – Ayer by Harper & Row, New York.
5. Instrumental methods of chemical analysis – by B. K. Sharma

### SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAC03	Core 11: Industrial Analysis	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Describe standard methods of analysis for pharmaceutical products.
- Discuss various methods of analysis for fertilizers.
- Classify insecticide & Pesticides.
- Describe various forensic analysis.

#### Unit 1. Pharmaceutical analysis (12 Hrs.)

Introduction to Pharmacopeia and Pharmacopeial analysis, Physical tests: Disintegration tests, Dissolution tests (tablets, capsules). Chemical Tests and Assays: Limit test, characteristics of limit tests specificity sensitivity, Loss on drying, loss on ignition, limit test for lead, arsenic, chloride moisture determination by KFR titration method.

#### Unit 2. Analysis of Fertilizers (10 Hrs.)

Sampling and sample preparation, analysis of nitrogen, phosphorus and potassium. Nitrogen: urea nitrogen, total Kjeldahl nitrogen methods, Ammonia nitrogen. Phosphorus: total phosphorus, available and non-available, alkalimetric ammonium molybdophosphate method. Potassium: potassium by sodium tetraphenyl borate method.

#### Unit 3. Pesticides and insecticides analysis (08 Hrs.)

Introduction and history, classification of pesticides and insecticides, formulation and analysis of Pesticides and insecticides.

#### Unit 4. Forensic analysis (10 Hrs.)

Special features of Forensic analysis, sampling, sample storage, sample dissolution, classification of **poisons**, lethal dose, significance of LD<sub>50</sub> and LC<sub>50</sub>. Identification and Analysis in the suspects: Poisonous elements viz. As, Pb, and Hg. Gun powder Residues, Poisoning due to cyanide, dioxines & Physiological effects of natural poisons such as Colchicine, Morphine, Nicotinoids.

#### Unit 5. Analysis of Selected Materials (08 Hrs.)

Principles of estimation of biological fluids. Estimation of hemoglobin, cholesterol and blood sugar (clinical and enzyme assays). Analysis of Alcoholic Beverages. Determination of quality parameters such as original extract, alcohol, extract, CO<sub>2</sub>, O<sub>2</sub>, pH value, carbohydrate.

### References Books

1. Vogel's textbook of quantitative inorganic analysis, L.Barrt et al ELBS.
2. Official method of analysis, 11<sup>th</sup> Edition (1970), W. Horwitz (Editor) Association of official analytical chemist, Washington DC..
3. Indian, British and U.S. pharmacopeia.
4. The chemistry of Process development & in fine chemicals & Pharmaceuticals industry.(C.Some S NaraRao) Asian BooKs Pvt. Ltd.
5. D.A. Skoog, D.M. West and F.J.Holler, "Fundamental Analytical Chemistry",Saunders College publishing.
6. C.A. Watson, "Official and Standardized Methods of Analysis", 3rd Edition.
7. S.M. Khopkar, "Environmental Pollution Analysis".
8. F.W. Fifield and P.J. Haines, "Environmental Analytical Chemistry".
9. B.J. Alloway and D.C. Ayres, "Chemical Principles of Environmental Pollution".
10. Pharmacopeia of India Volume I and II.

### SEMESTER III (SPECIALIZATION IN ORGANIC CHEMISTRY)

16PCEAC04	Core 12: Computer Based Test	-	1 Credits
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- An objective computer based test covering syllabus of SEM-I to III.

**SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)**

<b>16PCEAD01</b>	<b>DSE –Core -1: Chemistry of Food Analysis</b>	<b>4 hrs./Wk</b>	<b>4 Credits</b>
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**Objectives:**

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

- Classify enzymes, lipids, proteins and vitamins.
- Describe various methods of activation and inactivation of enzymes.
- Discuss various physical and chemical tests for oils and fats.
- Understand separation, digestion and metabolism of proteins.
- Occurrence, characteristic and reactivity of Pigments and Synthetic Dyes.

**Unit 1. Enzymes: (10 Hrs.)**

Introduction – Definition, occurrence, classification and chemical nature  
Properties of enzymes – mechanism of action; methods of assay; specificity; effect of temperature, pH and enzyme-substrate concentrations; activations, inhibition and their kinetics; various methods of inactivation; enzymes as catalysts; enzymes as proteins; isoenzymes and coenzymes Important enzymes of foods Enzymes involved in food deterioration, types/nature of reactions catalyzed and preventive measures Enzymes as aids in food processing operations – types/nature of reactions catalyzed and economical significance Biotechnological applications of enzymes.

**Unit 2. Lipids: (10 Hrs.)**

Introduction and definition of lipids and their classification Various types of lipids – Simple, conjugated, phospholipids and their occurrence in foods Various fatty acids occurring in fats and oils Fatty acid composition and physical and chemical characteristics of Various fats and oils, Iodine value, saponification value, acid Value, Polenski value, Reichert-Meissel value of important oils Storage changes in fats and oils, antioxidation, effect of various metals, Ions, effects of moisture, surface area and antioxidants Refining of fats and oils; Hydrogenation of vegetable oils. Characteristics tests for various oils. Determination of adulteration in fats and oils. Various methods used for measurement of spoilage of fats and fatty foods.

**Unit 3. Proteins: (10 Hrs.)**

Chemistry and classification of amino acids and proteins Reaction of amino acids Physico-Chemical properties of protein and their structure Methods of estimation of amino acids and proteins Chromatographic separation of amino acids and proteins Chemical interactions involving amino acids and proteins Nature of food proteins – Plant, animal and other relative merits Digestion, absorption and

metabolism of proteins Chemical and biological evaluation of nutritional quality of proteins.

**Unit 4. Vitamins: (10 Hrs.)**

Classification of vitamins, natural sources, effect of factors like light, heat, pH, redox conditions, etc., on their stability Chemistry of vitamins, chemical structure and biological activity Functions of vitamins as coenzymes and their deficiency diseases Biochemistry of vitamin binding properties Hypervitaminosis A, role of vitamin D in calcium metabolism, vitamin C and connective tissue formation Chemical reactions and estimation of vitamins in foods Principles of microbial assay of vitamins of B-series.

**Unit 5. Pigments and Synthetic Dyes: (08 Hrs.)**

Natural pigments, their occurrence and characteristic properties Carotenoids, their structure, occurrence and importance in food Anthocyanin, flavone, their occurrence in food, degradation products in food and importance Chlorophyll, their occurrences, characteristic properties, degradation during food processing Methods of detection of various natural pigments – carotenoids, chlorophyll, anthocyanins Permitted synthetic dyes Non-permitted synthetic dyes used by industries Harmful effects of non-permitted dyes used by industries Method of detection of permitted and non-permitted dyes.

**Reference books**

1. Chemical Analysis of Food: Techniques and Applications, 1st Edition by Y Picó; 2012, Elsevier; ISBN :9780123848635.
2. Food Analysis by S. Suzanne Nielsen; 2010, Springer; ISBN: 978-1-4419-1477-4.



### SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAD02	DSE –Core -1: Environmental & Green Chemistry	4 hrs./Wk	4 Credits
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#### Objectives:

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

- Understand energy resources, their alternate resources and energy conservation policies.
- Discuss types & effect of environmental pollution and pollutant.
- Describe the causes, and strategies to minimize Water & Air pollution.
- Understand principles of green chemistry and its application to lower the pollution.

#### Unit 1. Energy Resources and Conservation (10 Hrs.)

Renewable and non-renewable energy resources, growing energy need, solar energy, solar radiation and its spectral characteristics, fossil fuels classification, composition. Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principle of generation and conservation of conventional and non-conventional energy. Energy from biomass, anaerobic digestion, energy use pattern and future need projection in different parts of the world, energy conservation policies.

#### Unit 2. Environmental Pollution (10 Hrs.)

Types and major sources of air pollutants, effects of air pollutants on physico-chemical and biological properties surrounding atmosphere, air born diseases and their effects on health. Types and major sources of water pollutants, effects of water pollutants on physico-chemical and biological properties of water bodies, water born diseases with special reference to water pollution. Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil. Air, drinking water and waste water quality standard. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution sources and their effects on surrounding environment. Solid waste disposal and its effects on surrounding environment.

#### Unit 3. Water Pollution (10 Hrs.)

Classification of water bodies; physico-chemical and biological properties of fresh water; water quality standard, major sources of water pollution; physico-chemical and biological properties of sewage; quality of industrial effluents produced from textile, dairy, leather, thermal power and chemical industries, changes in water quality due to discharge of city sewage, changes in water quality due to discharge of industrial effluents from textile, dairy, leather, thermal power and chemical industries, effects of water pollutants on phytoplankton productivity; bio-indicators of water pollution. Various stages of treatment of sewage with special

reference to secondary treatments, (activated sludge, oxidation ponds, trickling filter), advanced waste water treatments, biological treatment of waste waters, treatment of industrial effluents released from textile, dairy, leather, thermal power and chemical industries; ozonization of secondary treated waste water; chemical and other methods for disinfection. Water management strategies, rain water harvesting, recharging of ground water, use of domestic waste water, recycling of waste water, recycling of industrial effluent after treatment.

**Unit 4. Air Pollution (10 Hrs.)**

Basic principles of air pollution management, ambient concentrations of air pollutants and trace gases, national environmental policies, implementation of policies and organization of management agencies, national air monitoring programme, effects of air pollution on human health, air quality criteria and case study, emergency preparedness, safety planning and management, vehicular pollution, monitoring and abatement technologies. Air pollution control equipments, objectives and types of control equipments, efficiency of separating devices, control of particulate emission settlers, cyclones, filters, scrubbers and esp; control of sulphur dioxide from lean and rich waste gases (recovery of sulphur and sulphuric acid); control of NO<sub>x</sub> through absorption and other newer methods; control of vehicular emission (catalytic conversion devices); Indoor air pollution and its control; Hazardous air pollutants and their management.

**Unit 5. Green Chemistry (08 Hrs.)**

Principles of Green Chemistry and its applications, environmentally benign reaction like strecker synthesis, Reformatsky reaction, Grignard reaction, Dieckmann condensation. Principles of microwave assisted organic synthesis & Knoevenagel condensation, Biginelli reaction, Ugi Coupling, Miyaura coupling, Stille coupling & Inorganic catalysts.

**Reactions in Ionic liquids:** Introduction & classification of ionic liquid, application of ionic liquid in following reactions: Diels Alder cycloaddition, Knoevenagel condensation, Friedel-Crafts alkylation.

**Reference Book**

1. Robert Ricklefs (2001). The Ecology of Nature. Fifth Edition. W.H. Freeman and Company.
2. Singh K.P. and J.S. Singh (1992). Tropical Ecosystems: Ecology and Management. Wiley Eastern Limited, Lucknow, India.
3. Smith, R.L. (1996). Ecology and Field Biology, Harper Collins, New York.
4. Botkin, D.B. and Keller, E.A. 2000. Environment Science: Earth as a living planet. Third Edition. John Wiley and Sons Inc.
5. Environment Studies by S. K. Dhameja
6. Basics of Environment Studies by Rahul Kansal.

### SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

<b>16PCEAC05</b>	<b>Core Practical-3:</b> Analysis of Industrial Products & Viva Voce	<b>10 hrs./Wk</b>	<b>5 Credits</b>
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#### 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.

#### Industrial Formulation Development Practical

- 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) Preparation and evaluation of face powder, lipstick, cold cream, vanishing cream, tooth paste/ tooth powder.
- 5) **Formulation and evaluation** of syrup, emulsion (o/w, w/o), turpentine liniment, calamine lotion.
- 6) Formulation and evaluation of milk of magnesia/aluminum hydroxide gel antacid suspension.
- 7) Formulation and evaluation of dry suspension.
- 8) Formulation and evaluation of diclofenac sodium gel.
- 9) Formulation and evaluation of eye drops.
- 10) Formulation and evaluation of metronidazole infusion.

**SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)**

<b>16PCEAD03</b>	<b>DSE-Core -1 Practical:</b> Chemistry of Food & Drug Analysis & Viva Voce	<b>2 hrs./Wk</b>	<b>1 Credits</b>
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- Practicals of Chemistry of Food & Drug Analysis.
  1. Determination of aqueous acidity and alcoholic acidity of foods
  2. Saponification value and unsaponifiable matter of fats and oils.
  3. Refractive index, Iodine value, TBA value, Free fatty acids of fats and oils
  4. Determination of protein in foods by Folin-Ciocalteu method
  5. Determination of total and acid insoluble ash
  6. Spectrophotometric determination of reducing and total sugars
  7. Determination of sugar by volumetric method.
  8. Determination of vitamin A by colorimetry
  9. Spectrophotometric determination of carotenes
  10. Determination of vitamin C by volumetric method
  11. Determination of benzoic acid in foods by volumetric method

**Industrial Analysis**

- Electro Analytical estimation of Drugs and related products.
- Content determination of chemical and agrochemical products.

**SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)**

<b>16PCEAD04</b>	<b>DSE-Core -1 Practical:</b> Environmental & Green Chemistry & Viva Voce	<b>2 hrs./Wk</b>	<b>1 Credits</b>
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- Practicals of Environmental & Green Chemistry.

### SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

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

40% of the students (on the basis of Merit/Test/Interview) admitted for the specialized course 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 will be carried out during practical examination of Sem-IV.

**SEMESTER III (SPECIALIZATION IN ANALYTICAL CHEMISTRY)**

<b>16PCECE03</b>	<b>Pilot Plant Operation</b>	<b>1 hrs./Wk</b>	<b>1 Credits</b>
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**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 (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAC06	Core 13: Regulatory Affairs & IPR	5 hrs./Wk	5 Credits
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### Objectives:

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

- Understand and describe terminology used in patents.
- Describe about various Drug regulatory and accrediting agencies of the world.
- Conclude the requirement of Good Manufacturing & Good Laboratory Practices.
- Illustrate Drug Development & Approval Process.

### Unit 1. IPR: (10 Hrs.)

Types of IP, definition, scope, objectives Patents, types, contents of patent, claims and types of claims, key terminology used in patents (Application, examiner, prior art, priority, specifications, provisional and non-provisional applications, claims, applicant, assignee, inventor, anticipation, obviousness, infringement and invalidation). Patent infringement, Greening of patent, Polymorphism and Patent

### Unit 2. Quality Control and Quality Assurance: (10 Hrs.)

Introduction, concept and philosophy of Total Quality Management System, GMP, ICH and ISO 9000, Drug regulatory and accrediting agencies of the world (USFDA, TGA, ICH, WHO, etc).

### Unit 3. Good Manufacturing & Good Laboratory Practices: (12 Hrs.)

- **Personnel:** responsibilities, training, hygiene.
- **Premises:** Location, design, plant layout, construction, maintenance and sanitation, environmental control, utilities and services like gas, water, maintenance of sterile areas, control of contamination.
- **Equipments:** Selection, purchase specifications, maintenance, clean-in-place, sterilize-in-place, methods.
- **Raw materials:** Purchase specifications, maintenance of stores, controls on raw materials and finished dosage forms.
- **Manufacture of and controls on dosage forms:** Manufacturing documents, master formula, batch formula records, standard operating procedures, quality audits of manufacturing processes and facilities. In process quality controls on various dosage forms, Packaging and labeling control, line clearance, reconciliation of labels, cartons and other packaging materials.
- **Quality Control Laboratory:** good laboratory practices, Responsibilities, routine controls instruments, reagents, sampling plans, standard test procedures, protocols, non-clinical testing, controls on animal house. Data generation and storage, quality control documents, retention samples, records and audits of quality control facilities. Finished products release, quality review, quality audits, batch release document.

**Unit 4. Drug Development & Approval Process: (10 Hrs.)**

- Drug development stages: target selection, pre-clinical development and clinical development. New Drug approval process:
  - a. National drug regulatory requirements, national drug policy, Drugs and Cosmetics Act and its amendments, Overview of schedules, details of schedule M, Schedule Y.
  - b. FDA guidelines on IND, new drug approvals (NDA), ANDA approvals.

**Unit 5. International Regulatory Agencies: (06 Hrs.)**

- Brief and comparative introduction to various regulatory agencies: USFDA, MCA, TGA, MHRA, ANVISA, CTD, WHO, ICH, SUPAC, CDSCO etc. Preparation of DMF, SMF and other regulatory documents.

**Reference books**

1. Guidelines for Developing National Drug Policies; WHO Publications, 1998.
2. Quality Assurance of Pharmaceuticals–A Compendium of Guidelines and Related Materials, Vol.–1; WHO Publications.
3. A Guide to Total Quality Management by Kaushik Maitra and Sedhan K. Ghosh. M. PHARM. (PHARMACEUTICAL MANAGEMENT AND REGULATORY AFFAIRS)-R13 Regulations 8
4. GMP by Mehra.
5. How to Practice GMP by P.P. Sharma.
6. ISO 9000 and Total Quality Management by Sadhan K.Ghosh.
7. Good Manufacturing Practices for Pharmaceuticals-A Plan for Total Quality Control by Sidney H. Willing & James R Stoker. (Drugs & Pharm. Sciences) Vol. 78; Marcel Dekker Inc.
8. OPPI-Quality Assurance.
9. Current good manufacturing practices for pharmaceuticals by Manohar A. Potdar



## SEMESTER IV (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAC07	Core 14: Analytical Method Development, Validation & Stability Studies	4 hrs./Wk	4 Credits
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### Objectives:

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

- Understand the concepts of process validation, IQ, OQ and PQ.
- Describe importance of Validation of analytical procedures of APIs.
- Discuss the concept of ICH guidelines.
- Outline stability and degradation studies.

### Unit 1. Introduction: (10 Hrs.)

An Introduction to the Basic Concepts of Process Validation & How it Differs from Qualification (Installation Qualification (IQ), Operational Qualification (OQ) & Performance Qualification (PQ) Procedures, Validation master plan (VMP), Analytical Method Development, Selection of method, method transfer.

### Unit 2. Analytical Validation-1: (10 Hrs.)

Need of analytical validation, Validation of Active Pharmaceutical Ingredients (APIs) and finished products, ICH guidelines on Validation of analytical procedures: text and methodology Q2 (R1).

### Unit 3. Analytical Validation-2: (10 Hrs.)

A Review of Prospective, Concurrent, Retrospective Validation & Revalidation including the use of Statistical Process Control, Validation of Water (Dematerialized, Distilled and Water for Injection), Cleaning Validation, Validation of Sterile and Non-Sterile Facility.

### Unit 4. Stability: (10 Hrs.)

An Introduction to the Basic Concepts of Stability studies, ICH guidelines on Stability Testing of New Drug Substances and Products: Q1A (R2) to Q1F.

### Unit 5. Degradation: (08 Hrs.)

A Review of accelerated and long term stability studies, stress testing and forced degradation studies. Degradation products, Outline on Design, Construction and function of stability chambers and rooms.

### References Books

1. Lachman L Liberman Theory and practice of industrial pharmacy by 3 rd edition
2. Sidney H Willing, Murray M, Tuckerman. Williams Hitchings IV, Good manufacturing of pharmaceuticals (A Plan for total quality control) 3rd Edition. Bhalani publishing house Mumbai.
3. Tablets Vol. I, II, III by Leon Lachman, Herbert A. Liberman, Joseph B. Schwartz, 2<sup>nd</sup> Edn. (1989) Marcel Dekker Inc. New York.

4. Text book of Bio- Pharmaceutics and clinical Pharmacokinetics by Milo Gibaldi, 3<sup>rd</sup> Edn, Lea & Febriger, Philadelphia.
5. Pharmaceutical process validation (Drugs and Pharmaceuticals Series), Ira R. Berry and Robert A. Nash, 2nd Edn.(1993), Marcel Dekker Inc., New York.
6. Dissolution, Bioavailability and Bio-Equivalence by Abdou H.M, Mack Publishing company, Eastern Pennsylvania.
7. Remingtons Pharmaceutical Sciences, by Alfonso & Gennaro, 19th Edn. (1995)OO2C Lippincott; Williams and Wilkins A Wolters Kluwer Company, Philadelphia.
8. Indian Pharmacopoeia, 2008, The Controller of Publications, Govt. of India.
9. Drug Formulation Manual- by D.P.S Kohli and D.H Shah, 1st Edn.(1998), Eastern publishers, New Delhi
10. The Pharmaceutical Sciences; the Pharma Path way 'Pure and applied Pharmacy' by D. A Sawant, Pragathi Books Pvt Ltd.
11. Pharmaceutical Quality Assurance by Manohar A. Potddar, 2nd edition 2007, Nirali Prakashan, Mumbai

## SEMESTER IV (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAC08	Core 15: Dissertation OR Practical	16 hrs./Wk	10 Credits
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### Dissertation

40% of the students (on the basis of Merit/Test/Interview) admitted for the specialized course 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 will be carried out during practical examination of Sem-IV.

### Practical

- Chemical / Instrumental analysis of the followings:  
Dyes & Intermediates / Pharmaceutical products / Agrochemicals / Petroleum & Polymer.

## SEMESTER IV (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAD05	DSE – Core -2: Selected Techniques in Analytical Chemistry	4 hrs./Wk	4 Credits
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### Objectives:

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

- Discuss and describe the methods of analysis for the radio-chemical analysis.
- Distinguish between various thermo analytical methods.
- Explain various extraction methods.
- Account types and applications of electrophoresis.

### Unit 1. Radio-Chemical Methods of Analysis: (10 Hrs.)

Origin of radio activity, decay modes, isotopes, units of radio activity  
Measurements of radio activity: detector based on ionization, photo effect, chemical reaction; Analytical applications of radio isotopes: isotope dilution, activation analysis, autoradiography, radio immunoassay.

### Unit 2. Thermal Analytical Methods: (10 Hrs.)

Introduction, instrumentation, applications of: Thermogravimetry (TGA), Differential thermal analysis (DTA), differential scanning calorimetry (DSC), Dynamic mechanical analysis (DMA), Thermo mechanical Analysis (TMA).

### Unit 3. X-ray Diffraction: (10 Hrs.)

Introduction, generation of X-rays, X-ray diffraction, Bragg's law, X-ray powder diffraction, X-ray single crystal diffraction interpretation of diffraction pattern, applications.

### Unit 4. Extraction Techniques: (10 Hrs.)

Solvent extraction, Principle, selectivity, factor affecting, methods and modes of extraction. Aqueous two phase extraction, principle, process. Reverse micellar extraction, super critical fluid extraction, solid phase extraction.

### Unit 5. Electrophoresis: (08 Hrs.)

Introduction, types of gel electrophoresis, applications of gel electrophoresis techniques, immunoelectrophoresis, two dimension electrophoresis, detection of Protein and nucleic acids.

### Reference books

1. Instrumental methods of analysis by B. Shivasankar, Oxford university press, 2012, ISBN-0-19-807391-7.
2. Instrumental Methods of Analysis by B.K.Sharma. Goel publishing house merut, ISBN:81-8283-019-2.
3. Spectroscopy by G, R,Chatwal, himalaya publishing house, ISBN-978-81-8318-809-8.

## SEMESTER IV (SPECIALIZATION IN ANALYTICAL CHEMISTRY)

16PCEAD06	DSE – Core -2: Phytopharmaceutical Analysis	4 hrs./Wk	4 Credits
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### Objectives:

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

- Classify the types of metabolites & isolation methods of it.
- Describe various methods for the structure determination of natural products.
- Discuss study of quality control on various aspects including WHO guidelines.

### Unit 1. Introduction: (08 Hrs.)

Introduction, Classification, source, types of extraction, Primary and secondary metabolite, Extraction and isolation methods of metabolite.

### Unit 2. Phytochemical methods: (10 Hrs.)

Qualitative and Quantative phytochemical methods for the structure determination of natural products.

### Unit 3. Phytochemical Analysis: (10 Hrs.)

Quality control of crude drugs: proximate analysis including ash and extractive values, crude fiber content, U.V. and fluorescence analysis of powdered drugs. Qualitative & quantitative microscopy and microchemical tests.

### Unit 4. Phytochemical & quality control: (12 Hrs.)

Detection of common adulterants and insects infestation in whole and powdered drugs. Analysis of official formulations derived from crude drugs including some ayurvedic preparations. Brief study of quality control of plant-products and their high-throughput screening. Microbiological screening methods for antimicrobial activity.

### Unit 5. Quality control Guidelines: (08 Hrs.)

WHO guidelines for the quality control of raw materials used in herbal formulations.

### References Book

1. Phytopharmaceutical Analysis by Ramadoss Karthikeyan Oruganti Sai Koushik, 2016; LAP Lambert Academic Publishing, ISBN-10: 3659886009.
2. Phytopharmaceutical Technology by List and Schmidt, 1990; CRC press, ISBN 9780849377099.
3. Chemistry of Natural Products by Gurdeep Chatwal, 1992.
4. Natural Product-A new source of drug discovery by J. D. Newman and G. M. Cragg.

**SEMESTER IV (SPECIALIZATION IN ANALYTICAL CHEMISTRY)**

<b>16PCECE04</b>	<b>Instrumental Training</b>	<b>1 hrs./Wk</b>	<b>1 Credits</b>
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**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