



**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**

M. Sc. Pharma. Organic Chemistry

SEMESTER I

16PCHCC01	Core 1: Inorganic Chemistry	4 hrs./Wk	4 Credits
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Objectives:

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

- Understand Molecular Orbital & Valence Bond theories of bonding.
- Describe Huckel's theory & its applications to Ethylene, Butadiene and Benzene.
- Understand the basic principle, theory and instrumentation of Mössbauer Spectroscopy
- Identify the possible inorganic complexes/salt which can be analyzed and Interpret the Mössbauer Spectra for structure determination
- Understand preparation, chemical and physical properties and applications of organic and inorganic Reagents in inorganic analysis.
- State the principle, draw instrumentation and describe theory and applications of ESR
- Illustrate Zeeman levels & Calculate the energies of Zeeman levels
- Describe bonding, synthesis and application of σ - & π -bonded organometallic compounds.

Unit 1. Quantum Mechanics and its Applications: (10 Hrs.)

- MO-VB Theory: Born-Oppenheimer approximation, Hydrogen Molecule ion. LCAO-MO and VB treatments of hydrogen molecule.
- Electron Density, forces and their role in chemical bonding.
- Hybridization and valence MO's of H₂O, NH₃ and CH₄.
- Hückel pi-electron theory and its applications to Ethylene, Butadiene and Benzene.
- Idea of Self-consistent field method.

Unit 2. Mössbauer Spectroscopy: (09 Hrs.)

- Introduction of Mössbauer effect, Isomer- Shift,
- Magnetic hyperfine interactions.
- Quadrupole moment. Electric field gradient, Quadrupole splitting,
- Applications in Structure determination.

Unit 3. Electron Spin Resonance: (09 Hrs.)

- Introduction to Electron Spin Resonance,
- Technique of electron spin resonance, interaction between nuclear spin and electron spin:- hyper fine splitting,
- Calculation and energies of Zeeman levels, calculations of energies, frequency and the ESR spectrum when one electron influenced by a single proton and one electron delocalize over two equivalent protons.

Unit 4. Uses of Organic and Inorganic Reagents in Inorganic Analysis: (11 Hrs.)

- Cupferron, Dithiozone, Aluminon, Oxine, Dithiooxamide,
- α -Benzoinoxime, α -Nitro- β -naphthol, α -Nitroso- β -naphthol,
- Diphenyl carbazone, Diphenyl carbazide,
- Pyrogallol, Benzidine, Salicylaldehyde, *o*-Phenanthroline,
- Potassium bromate (KBrO_3), Potassium iodate (KIO_3),
- Ammonium vanadate (NH_4VO_3), Ceric sulphate [$\text{Ce}(\text{SO}_4)_2$], Ethylenediaminetetraacetic acid (EDTA).

Unit 5. Organometallic Complexes: (09 Hrs.)

- Introduction, bonding and structure & Classification,
- Synthesis and application of:
 - σ -bonded Organ transition metal compounds
 - π -bonded (alkenes, alkynes, allyl, cyclopentadiene and arene) Organometallic compounds.

Reference Books

1. Prasad, R. K. (2004, Second edition) *Quantum Chemistry*. New Delhi: New Age International (P) Ltd. (ISBN: 81-224-1264-5).
2. Chandra, A. K. (2008, Fourth edition) *Introductory Quantum Chemistry*, New Delhi: Tata McGraw-Hill. (ISBN: 0-07-462054-1).
3. Drago, R. S. (1977) *Physical Method in Chemistry*. Philadelphia: Saunders College Publishing. (ISBN: 0721631843).
4. Singh, A.; Singh, R. (2005) *Textbook of Inorganic Chemistry Vol. I & II*. New Delhi: Campus Books International (ISBN: 8180300714).

5. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989, Fifth edition) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
6. Crabtree, R. H. (2005, Fourth edition) *The Organometallic Chemistry of the Transition Metals*. Hoboken: John Willey & Sons (ISBN: 0-471-66256-9).
7. Mehrotra, R. C. and Singh, A. (2004, Second edition) *Organometallic Chemistry A Unified Approach*, New Delhi: New Age International (P) Ltd. (ISBN: 81-224-1258-05).

SEMESTER I

16PCHCC02	Core 2: 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 path Way & Reactive Intermediates: (06 Hrs.)

Homolytic and Heterolytic fission, Different types of arrow notation, Electrophile and Nucleophile, Carbocation, Carbanion, Free radical, Carbene, Nitrene, Ylides, Dithioketene acetal and Enamines.

Unit 2. Reaction based on Reactive Intermediates: (12 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,
- **Carbene:** Wolf Rearrangement, Riemer-Tiemann reaction
- **Nitrene:** Hoffmann, Curtius, Schmidt Rearrangement
- **Ylides, Enamines and Dithioketene 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) LiAlH₄ (LAH) (6) *m*-Chloroperbenzoic acid (MCPBA), (7) N-Bromosuccinimide (NBS), (8) Triphenylphosphene (TPP), (9) Aluminium isopropoxide (Al(*O-i-Pr*)₃), (10) *n*-Butyllithium (*n*-BuLi), (11) Osmium Tetroxide (OsO₄), (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 Czakó (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 I

16PCHCC03	Core 3: Physical Chemistry	4 hrs./Wk	4 Credits
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Objectives:

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

- Understand concepts & theories of statistical thermodynamics and related statistical methods with its applications.
- Understand the ideal properties & behaviour of solutions and various equilibria
- Determine of Molecular weight from freezing and boiling point.
- Understand the Chemical equilibrium in homogeneous & heterogeneous systems & catalysis. Free energy change in chemical reactions and their applications.
- Understand structure and chemical & thermal properties of Polymers.
- Understand spectroscopic & thermal methods of polymer analysis and apply the same for the identification of polymers.

Unit 1. Statistical Thermodynamics: (11 Hrs.)

Basic Terms: probability, cell, phase space, micro and macro states, thermodynamic probability, statistical weight factor, assembly, ensemble and its classification and statistical equilibrium. Derivation of Boltzmann-Maxwell, Bose-Einstein and Fermi- Dirac statistics, Partition function and derivations of translational, rotational, vibrational and electronic partition functions and thermodynamic functions such as internal energy, heat capacity, entropy, work function, pressure, heat content, etc. Partition function & third law of thermodynamics. Applications of partition function to monoatomic gases, diatomic molecules, equilibrium constant and equilibrium constants of metathetic reactions. Problems

Unit 2. The Properties of Solutions: (09 Hrs.)

Ideal solutions: Properties, the Duhem-Margules equation, vapour pressure curves. Composition of liquid and vapour in equilibrium influence of temperature on gas solubility and solid-liquid equilibria. Non ideal solutions: Deviation from ideal behaviour, vapour pressure curves, liquid and vapour compositions. General equations for liquid mixtures, partially miscible liquids

Dilute solutions: Henry's law. Determination of molecular weights from freezing and boiling points. Problems.

Unit 3. Free Energy and Chemical Reactions: (09 Hrs.)

Chemical equilibrium and the equilibrium constant: Equilibrium in homogeneous gaseous systems. Homogeneous reactions in liquid solutions. Homogeneous reactions in dilute solutions. Chemical equilibria in heterogeneous systems. Free energy change in chemical reactions: The reaction isotherm, standard free energy of reaction, the direction of chemical variation of equilibrium constant with pressure and temperature. Influence of temperature on heterogeneous reactions. Integration of the Van 't Hoff equation. Variation of standard free energy with temperature. Simultaneous equilibria. Formation of standard free energies and entropy changes and their applications, problems

Unit 4. Homogeneous & Heterogeneous Catalysis: (08 Hrs.)

Introduction, types of catalysis (Homogeneous & heterogeneous) & their characteristics. Theory of catalysis, autocatalysis, promoters or activators, types of acid base catalysis. Mechanism of acid-base catalysis & catalytic coefficients, Enzyme catalysis.

Unit 5. Polymer Chemistry: (11 Hrs.)

Introduction & classification of polymers, chemical analysis, spectroscopic methods, X-ray diffraction and microscopic methods, thermal methods (DSC, DTA, TGA), differential and integral methods of kinetics, analysis, effect of various operating parameters, thermal stability index, physical methods of testing: mechanical properties like stress, strain, modulus and compliance; fatigue tests, impact test, tear resistance, hardness, abrasion resistance, thermal properties: softening temperature and flammability, optical properties: transmittance and reflection, colour, glass transparency, electrical properties: dielectric constant and loss factor, resistivity, dielectric strength and arc strength, effect of temperature on structure of polymers, Chemical properties: resistance to solvents, vapour permeability and weathering.

Reference Books

1. Glasstone, Samuel. (2007) *Thermodynamics for Chemists*: Narahari Press (ISBN: 1406773220).
2. Nash, L. K. (2006, Second edition) *Elements of Statistical Thermodynamics*. America: Dover Publications (ISBN: 0486449785).
3. Gurdeep Raj (2014, Third edition) *Thermodynamics*. Meerut: GOEL publishing House (ISBN: 8187224886).
4. Gurtu, J. N. Gurtu, A. (2014, Twelfth edition) *Advanced Physical Chemistry*. Meerut: Pragati Prakashan (ISBN: 9350060191).
5. Barrow, Gordon M. (1996, Sixth edition) *Physical Chemistry*. New York: McGraw-Hill International. (ISBN: 0070051119).

SEMESTER I

16PCHCC04	Core 4: Pharmaceutical Engineering - I	4 hrs./Wk	4 Credits
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Objectives:

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

- Methods for Industrial measurement including temperature, viscosity, pressure, specific gravity and density, liquid level and flow measurement.
- Principles of Size reduction and working of various size reductions equipment's such as Jaw Crusher, Roll Crusher, Ball mill.
- Cumulative analysis & differential analysis & working of various types of screening equipments
- Understand principles & theory of leaching & extraction operations.
- Understand crystallization, properties of crystals, fractional crystallization and types of crystallizer.
- Operate mixing and homogenization equipments with reference to pharmaceutical applications.

Unit 1. Industrial Measuring Instruments: (12 Hrs.)

- **Temperature measurement:** Bimetallic thermometer, thermo electric sensors (thermo couple).
- **Viscosity Measurement:** Capillary tube viscometer, Ostwald Viscometer, Saybolt Viscometer.
- **Specific gravity & Density measurement:** Bubbler system, hydrometer method.
- **Liquid level measurement:** Sight glass method, float gauge, Radiation level measurement, bubbler level measurement.
- **Pressure Measurements:** Liquid column, manometers, purges system.
- **Flow measurements:** Venturimeter, Orificemeter, Pitot tube, rotameter.

Unit 2. Size Reduction: (08 Hrs.)

Objectives of comminution, factors affecting size reduction, principles of size reduction. Principles, construction & working of various size reductions equipment's such as Jaw Crusher, Roll Crusher, Ball mill.

Unit 3. Screening: (08 Hrs.)

Screening & Size distribution, cumulative analysis & differential analysis, determination of size, sieve analysis, standard sieve (US-standard & Tyler Standard). Principle, construction & working of various types of screening equipments.

Unit 4. Leaching & Extraction: (10 Hrs.)

Factors influencing the rate of extraction, equipment's, number of stages for counter-current washing. Calculation of the number of theoretical stages in extraction operation (Co-current contact with partially miscible solvents). Extraction Equipments.

Unit 5. Crystallization & Mixing: (10 Hrs.)

Growth & properties of crystals, Saturation, Nucleation, Crystallization rate, fractional crystallization, types of crystallizers. Equipments for solid mixing. Study of following mixtures: planetary mixture, agitator, triple roller mill, propeller mixture, pharmaceutical applications of mixing.

Reference Books

1. McCabe, W. L.; Smith, J. C.; Harriott Peter (2005, Seventh edition) *Unit Operations of Chemical Engineering*. New York: McGraw Hill Chemical Engineering Series (ISBN: 0072848235).
2. Peters, Max S. (1984, Second revised edition) *Elementary Chemical Engineering*. New York: McGraw Hill Chemical Engineering Series (ISBN: 0070495866).

SEMESTER I

16PCHCC05	Core Practical -1: Inorganic, Organic, Physical Chemistry, Pharmaceutical Engineering - I & Viva Voce	12 hrs./Wk	6 Credits
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Objectives:

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

- Isolate, Purify & Identify the unknown mixture of Organic compounds & Inorganic salts by applying principles of qualitative analysis.
- Develop synthetic skill (plan & produce) based on stoichiometric, reactivity, reaction condition optimization & separation technique principles.
- Characterize natural & synthetic products using physical & spectroscopic techniques.
- Calibrate & validate various opto / electro instrumental methods of analysis
- Measure & correlate the physicochemical properties of chemicals/materials using various opto / electro instrumentation techniques.
- Plan & perform qualitative & quantitative analysis of chemicals/materials following GLPs.

1. Inorganic Chemistry:

- a. **Qualitative Analysis:** Analysis of a mixture containing six radicals including one less common / rare metal ion.
- b. **Preparation of Metal Complexes:** Preparation of selected inorganic metal complexes & purification by crystallization.

2. Organic Chemistry:

- **Organic preparation:** Electrophilic substitution reactions and Functional group interconversion.

3. Physical Chemistry:

Calibration & Instrumentation:

- **Conductometry:** Mono and biprotic acids, mixtures of acids against strong/weak bases, hydrolysis constant, verification of Onsagar's equation

- **pH metry:** Quantitative drug analysis, Hammett constant, hydrolysis constant of electrolytes, acid-base titration, pKa of acids and $E^0_{QH_2}$.
- **Refractometry:** Molar refraction, refractive index, composition of Binary mixtures.
- **Spectrophotometry:** Maximum absorption, Lambert-Beers Law, drug estimation, indicator constant.
- **Adsorption:** adsorption isotherm
- **Potentiometry:** Acid-base, normality and dissociation constant, Redox and Argentometric titrations.
- **Ultrasonic:** Acoustical parameters of liquids, compressibility of binary mixture.

Physicochemical Exercises:

- **Partition Co-efficient:** Distribution of Benzoic acid in organic solvent & aqueous phase, equilibrium constant by distribution method.
- **Reaction Kinetics:** First and second order reactions-order determination, energy of activation.
- **Thermodynamics:** Heat of vaporization, Partial molar volume, etc.

4. Pharma. Engineering -I

- **Size Reduction & Screening:** Jaw crusher, roll crusher, ball mill, Screening etc.
- **Industrial Measurement:** Viscosity, density etc.

SEMESTER I

16PCHCE01	IT Tools for Chemist	1 hrs./Wk	1 Credits
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Objectives:

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

- Draw and develop chemical reaction mechanism & assemblies.
- Predict and correlate physicochemical & spectral properties and characteristics of chemical / materials
- Study spatial arrangement of molecules and energy minimization.
- Search & retrieve authenticated scientific reference materials using NLIST, ScienceDirect and SciFinder.

Unit 1. ChemDraw Ultra Software: (06 Hrs.)

Introduction of ChemDraw, Chem Sketch, Drawing chemical reaction, Structure drawing using templates, Structure to name and name to structure, Drawing mechanism of reaction, Diagram of Distillation Assembly, Chiral Structure Draw. Drawing apparatus used in laboratory. Reproducing reaction scheme from given research paper.

Introduction of 3D ChemDraw Ultra, export chemical structure from 2D to 3D, run energy minimization of given molecule, predicting log P value & other physicochemical parameters for given set of molecules.

Unit 2. NLIST: (02 Hrs.)

Introduction of NLIST website, available e-resources, access of e-books and research articles, e-learning through NPTEL

Unit 3. ScienceDirect: (02 Hrs.)

Introduction to publishing house, various journals formats, various search option, recent publication, citation index, impact factor, h-index.

Unit 4. SciFinder: (02 Hrs.)

Introduction, accessing SciFinder, keyword search, reaction search and data mining, patent search and referencing.

SEMESTER I

16PVE01	Value Education	1 hrs./Wk	1 Credits
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- Value Education

SEMESTER II

16PCHCC06	Core 5: 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.
- 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 5α - and 5β -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-B₂, pyridoxine-B₆), 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 II

16PCHCC07	Core 6: Organic Synthesis: A Disconnection Approach	5 hrs./Wk	5 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 δ -hydroxy carbonyl compounds, α,β -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 II

16PCHCC08	Core 7: Selected Topics in Pharmaceutical Chemistry	4 hrs./Wk	4 Credits
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Objectives:

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

- Understand the setup and applications of air and water pollution control methods.
- Learn the basic concept of green chemistry and green synthesis
- Aware about the internationally adopted guidelines like GMP, GLP and ICH for testing and manufacturing drug and health care products
- Skilled in calculating accuracy & precision, confidence limit & interval, test of significance & least square analysis
- Understand the concept and relevance of patents, copy rights, trademarks and geographical indications
- Learn the synthesis, characterization and applications of nano particles

Unit 1. Environmental Chemistry: (10 Hrs.)

Introduction, classification and causes of Air & Water pollution

- **Air pollution control methods and equipments like:** Cyclone Separator, Fabric Filter System, Electrostatic Precipitator, Wet Scrubber.
- **Water treatment methods & equipments like:** Screening, Sedimentation, Flootation, Activated Sludge Treatment, Trickling Filter, Oxidation Pond, Aerated Lagoons, Imhoff Tanks & RO.

Unit 2. Green Chemistry: (12 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.

- Unit 3. Pharma. Regulatory Affairs: (09 Hrs.)**
Introduction of regulatory affairs, ICH guidelines, GMP & GLP, SOPs, Patent search tools and their usages, Brief IPR-Introduction, Various Technical Terms (Up to 8), Legislation, IPA, Criteria for Patent. Polymorphism of drugs and IPR related issue.
- Unit 4. Analysis of Industrial Products: (08 Hrs.)**
Pesticide and Insecticide Analysis (BHC, DDT, Phosphomidon, Dichlorovos, Endosulphan, Phorate, Malathion, Parathion etc.)
Food additives, Adulteration & Testing.
- Unit 5. Nanotechnology: (09 Hrs.)**
Introduction, Physical methods of synthesis of nanomaterials: Mechanical & Vapour deposition, Chemical methods of synthesis of nanomaterials: Colloids & Colliding solutions, Synthesis of Colloids, Synthesis of metal nanoparticles, Properties and Applications.

Reference Books

1. Douglas A. Skoog, West, Holler, Crouch (2004, Eighth edition) *Fundamental of Analytical Chemistry*. Mexico: Thomson-Brooks/Cole (ISBN: 81-315-0051-9).
2. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
3. De, A. K. (2015, Seventh edition) *Environmental Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2617-5).
4. Trivedi, R. K.; Goel, P. K. (2003) *An Introduction to Air Pollution*. Horsham: Global Media Publications (ISBN: 8185771650).
5. *Course Manual on Water and Wastewater Analysis* (1979) Nagpur: National Environmental Engineering Research Institute (NEERI).
6. Nemerow, Nelson L. (1972) *Liquid waste of Industry: Theories Practices and Treatment*. Boston: Addison-Wesley Educational Publishers Inc (ISBN: 0201052644).
7. Lyer, S. (2003) *Guidelines on cGMP and Quality at Pharmaceutical Products*. Nashik: Career Publications (ISBN: 8188513008).

SEMESTER II

16PCHCC09	Core 8: Pharmaceutical Engineering -II	4 hrs./Wk	4 Credits
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Objectives:

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

- Types of Flow, viscosity measurement, Flow loss phenomena
- Transportation of fluid and working of various pumps
- Modes of Heat transfer, Equipment, Heat exchanger, fundamental of mass transfer.
- Understand types of Evaporation, Mass & Energy balance & working of various evaporators.
- Understand principles & theory of filtration and construction, working & advantages, disadvantages of various filters.
- Apply & Correlate different laws & principles of Distillation operation.

Unit 1. Heat Transfer: (10 Hrs.)

Modes of heat transfer, Conduction, Convection & Radiation, Heat transfer by conduction, Heat transfer through a rectangular slab, thermal resistance in series & parallel. Thermal conductivity. Heat transfer Equipments, heat exchanger, shell & tube heat exchanger. Calculations involving heat transfer coefficients.

Unit 2. Distillation: (10 Hrs.)

Vapour liquid equilibrium. Partial vaporization & partial condensation, partial pressures, Dalton's, Raoult's & Henry's laws, relative volatility, the methods of distillation, (two component mixtures), the fractionating column, (calculation of number of plate, efficiency), steam distillation, packed columns, general description, types of packing, flash distillation, fractional distillation, High vacuum distillation.

Unit 3. Evaporation: (08 Hrs.)

Types of evaporation, heat transfer coefficient, boiling point rise due to material in solutions, Mass & Energy balance over evaporator, single & multiple effect evaporators.

Unit 4. Flow & Transportation of Fluids: (10 Hrs.)

Types of flow, Reynolds number, Velocity distribution in pipes, Viscosity & its units, Bernoulli's equation, loss due to sudden enlargement & sudden contraction
Positive displacement pumps, reciprocating pumps, rotary pumps, centrifugal pumps, Diaphragm pump.

Unit 5. Filtration & Centrifugation: (10 Hrs.)

Introduction, classification of filters, Sand Filters, filter presses, Plate & frame presses, leaf filters, filter aids, filtration theory, washing of filter cakes. Principles of centrifugation, advantages, disadvantages & use of perforated basket centrifuge, centrifuge filter.

Reference Books

1. Sinko, P. J. (2010, Sixth edition) *Martin's Physical Pharmacy and Pharmaceutical Sciences*, New Delhi: B. I. Waverly Pvt. Ltd. (ISBN: 978-0-7817-9766-5).
2. Lachman, L.; Liebermann, H. A. (2013, Fourth edition) *Theory & Practise of Industrial Pharmacy*. New Delhi: CBS Publishers & Distributors Pvt. Ltd.
3. Gavhane, K. A. (2009, Seventeenth edition) *Unit Operations-I*. Pune: Nirali Prakashan. (ISBN: 978-81-96396-11-4).
4. Gavhane, K. A. (2009, Seventeenth edition) *Unit Operations-II: Heat & Mass Transfer Operations*. Pune: Nirali Prakashan. (ISBN: 978-81-96396-12-1).

SEMESTER II

16PCHCC10	Core Practical -2: Chemistry of Natural product, Pharmaceutical Chemistry, Pharmaceutical Engineering -II & Viva Voce	12 hrs./Wk	6 Credits
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Objectives:

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

- Calibrate & validate various opto / electro instrumental methods of analysis
- Measure & correlate the physicochemical properties of chemicals/materials using various opto / electro instrumentation techniques.
- Isolate, Purify and identify natural products using physical & spectroscopic techniques.
- Apply principles & operate fluid flow, heat transfer & size reduction mechanical operations

1. Pharmaceutical Chemistry

Part A: Analytical Chemistry

- **Standardization of solutions**
- **Food Analysis:** Honey, oil & fat, tea-leaves, ginger powder
- **Drug & Drug intermediate Analysis:** Aspirin, analzin, cephalaxin, maleic anhydride.
- **Water Analysis:** Water parameter determination (anionic, cationic, DO, BOD, COD etc.),
- **Miscellaneous analysis:** Dichlorovos, Tin solder wire, NaCl etc.

Part B: UV-VIZ. Spectroscopy: Scanning, shifts, transitions, linearity.

- **Organic mixture separation:** Ternary mixture separation and qualitative analysis of each component.

2. Chemistry of Natural product:

Extraction of Natural Products: Tea, Clove, Turmeric, Black pepper, Cinnamon etc.

3. Pharma. Engineering -II

- **Fluid Mechanics:** Bernoulli's equation, measurement of major & minor losses, Reynolds experiment etc.
- **Heat Transfer:** Fourier's law applicable to a composite slab, Heat transfer through insulating powder, Stefan Boltzmann law verification, Natural convection etc.

SEMESTER II

16PCHCE02	Scientific Writing (Research)	1 hrs./Wk	1 Credits
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Objectives:

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

- Learn searching & retrieving scientific literature and patent search using E-resources.
- Understand and write different international scientific publications (research article, review, proposal, patent and book)
- Prepare & present scientific article / proposal.

Unit 1. Literature search & retrieval: scientific peer reviewed research articles, review, patent etc. **(04 Hrs.)**

Unit 2. Full article, letters, note, communication, mini review and review with case study. **(04 Hrs.)**

Unit 3. Writing Research article & Review article preparation (Introduction, Objectives, Methodology, Result & discussion, Chemistry, Experimental section, Acknowledgement & References) **(08 Hrs.)**

Unit 4. Research Proposal for given topic (Introduction, Objectives, Chemistry, Methodology, Plan of Work, Resources required, References) & IP. **(08 Hrs.)**

Unit 5. Presentation (ppt) of recent research paper (full article, letters or review) published in the chemistry journals.