



**SarvodayaKelavaniSamaj managed,
Shri Manibhai Virani and Smt.NavalbenViraniScience College**

(Autonomous)

(Affiliated to SaurashtraUniversity, 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 –Grade A-1 by KCG, Government of Gujarat

GPCB-Government of Gujarat approved EnvironmentAuditCenter

Nodal Center for capacity building by GSBTM

Department of Chemistry

B.Sc. Chemistry

Syllabus

SEMESTER – I

Semester – I		
Course Code	Course Title	Course Credit and hrs
19UCHCC101	Core-1: Fundamentals of Chemistry-I	5 Credits - 5hrs / wk

Objectives:

To enable the students to

- Understand elementary concepts of atomic structure, bonding, and periodicity of elements.
- Understand molecular behavior of compounds in relation with their atomic bonding and electronic forces.
- Develop skills in the scientific method of planning, conducting, reviewing and reporting experiments of qualitative & quantitative chemical analysis.
- Develop skills in understanding, planning and performing experiments for titrimetric analysis.

Course content

Hours

Unit – 1: Structure of Atom

13 hrs

(1) Atomic Structure & Wave mechanics:

- Bohr's Theory & its limitation
- Quantum numbers
- Shape of orbitals
- Principles of Electronic configuration: AufBau, Pauli, Hund
- De-Broglie's dual nature equation
- Heisenberg's uncertainty principle & its significance
- Significance of ψ and ψ^2
- Schrodinger wave equation
- Normalized and orthogonal wave function
- Eigen function and Eigen value
- Postulates of wave mechanics
- Radial and angular distribution curves
- Radial and angular wave function for hydrogen atom
- Numericals

Unit – 2: Properties of Elements

15hrs

(2) Periodic Properties

Various periodic trends in periodic table

- Atomic radius
- Ionic radius – Effective nuclear charge
- Pauling's method for the determination of ionic radius
- Ionization energy
- Electron affinity
- Electronegativity
- Slater's Rule

(3) Chemical Bonding

- Introduction
- **Types of Bonds:**
 - Covalent, Co-ordinate Covalent, Ionic, Metallic, Vander Waal's Forces, Hydrogen Bond
- **Hybridization:**
 - sp – BeCl_2
 - sp^2 – BF_3
 - sp^3 – CH_4
 - sp^3d – PCl_5
 - sp^3d^2 – SF_6
 - sp^3d^3 – IF_7
- Valence bond theory and its limitations
- VSEPR theory (Sidgwick- Powell rule)

Unit – 3: Chemistry of Elements-I

15hrs

(4) Chemistry of S & P block and Noble gas Elements

- Introduction
- Occurrence & Electronic configuration
- Inert pair effect
- Relative stability of different oxidation states
- Diagonal relationship and anomalous behavior of first member of each group.
- Allotropy and catenation
- Complex formation tendency of p block elements
- Hydrides and their classification :Ionic, Covalent and Interstitial
- Study of the following compounds with emphasis on structure, bonding,preparation, properties and uses :
 - Boric acid, Boron nitrides, Borohydrides (diborane), Nitric acid, Nitrous acid,Sulphuric acid and Sulphurous acid,Interhalogen compounds

Noble gas

- Occurrence & Electronic configuration
- Rationalization of inertness of noble gases
- Clathrates
- Preparation and properties : XeF_2 , XeF_4 , XeF_6 , XeOF_4 , XeO_3 and XeO_4
- Applications of Noble gases

Unit – 4: Fundamentals of Analytical Chemistry – I

15hrs

(5) Quantitative Analysis:

- Introduction
- Types of Quantitative Analysis:Gravimetric Analysis, Volumetric Analysis.

Modes of Concentration:

- Introduction
- Solution : Solvent, Solute, Primary & Secondary standard solutions
- Determination of Molecular weight and eq. weight

- Different modes of concentration: Normality, Molarity, Molality, Mole fraction, % W/W, % W/V, % V/V, ppt with numericals.

(6) Inorganic Qualitative Analysis

- Introduction
- Solubility product
- Common ion effect
- H₂S scheme, NH₄Cl & NH₄OH scheme
- Borax bead test, Charcoal test, Cobalt nitrate test & Flame test

Unit – 5: Fundamentals of Analytical Chemistry – II

17hrs

(7) Acid- Base & Buffers

- Introduction, Definitions – Acids and Bases
- Strong and weak electrolytes
- Degree of ionization
- Ionic product of water
- Ionization of weak acid and weak base
- pH scale
- Salt hydrolysis
- Calculation of hydrolysis constant & degree of hydrolysis & pH of different salts
- Buffers & types of Buffers
- Mechanism of Buffers
- Determination of pH of Buffer by Henderson equation
- Buffer capacity

(8) Acid- Base & Redox Titrations

- Introduction
- Acid – Base titration :
 - Strong acid v/s Strong base
 - Weak acid v/s Strong base
- Redox titration :
 - Oxalic acid – KMnO₄
 - FeSO₄ – K₂Cr₂O₇
 - Iodo & Iodimetric

Text Books:

1. Puri, B. R.; Sharma, L. R. & Kalia, K. C. (2017, 33rd edition) *Principles of Inorganic Chemistry*. New Delhi : Milestone (ISBN No. 978-8192143330) (Unit-1, 2 & 3)
2. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2020, 28th edition) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 978-9352836093) (Unit-4 & 5)

Reference Books:

Inorganic Chemistry

1. Madan, R. L. (2011, 3rd edition) *Chemistry for degree student First year*. New Delhi: S. Chand (ISBN: 978-8121932301).
2. Lee, J. D. (2008, 5th edition) *Concise Inorganic Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 978-8126515547).

3. Peter Atkins, Tina Overton, JonarthanRourke, Mark Weller & Fraser Armstrong (2010, 5thedition) *Inorganic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-959960-8).

Analytical Chemistry

1. Douglas A. Skoog, West, Holler, Crouch (2004, 8thedition) *Fundamental of Analytical Chemistry*. Mexico: Thomson-Brooks/Cole (ISBN: 81-315-0051-9).
2. Sharma, B. K. (2014) *Instrumental Method of Chemical Analysis*. Meerut: GOEL publishing House (ISBN: 978-81-8283-099-8).
3. Christian, Gary D.; Dasgupta, Purnendu K.; Schug, Kevin A. (2007, 6th edition) *Analytical Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 978-81-265-1113-6).

Semester – I		
Course Code	Course Title	Course Credit and hrs
19UCHCC102	Core-2: Fundamentals of Chemistry-II	5 Credits - 5hrs / wk

Objectives:

To enable the students to

- Understand the fundamental concepts of organic chemistry & chemistry of hydrocarbons.
- Understand & use basic concepts of Stereochemistry and conformation.
- Use concepts of thermodynamics to make predictions and give explanations about chemical systems and fundamental properties of matter.
- Recognize forces acting on interface & within molecules and methods of reducing them for accelerating chemical reactions.
- Develop skills in safe handling & calibration of analytical glassware and preparation of standard solutions used in quantitative analysis.
- Develop skills in the determination of basic physical properties.

Course content

Hours

Unit – 1: Fundamentals of Organic Chemistry

15hrs

(1) Basics of Organic compounds

- **Organic compounds:** Classification, functional group, Nomenclature,
- **Hybridization :** sp- Ethyne, sp²- Ethene, sp³- Methane
- **Electronic Displacement Effects :**
 - Inductive effect,
 - Electromeric effect
 - Resonance (Mesomeric) effect
 - Hyper conjugation
- **Bond Fission :** Homolytic and heterolytic bond fission, Curly arrow rules
- **Type of Reagents :** Nucleophile, Electrophile & Free Radical
- **Reaction Intermediates:** Types, hybridization, formation, relative stability of :
 - Carbocation
 - Carbanion
 - Carbon free radical
- **Introduction to types of organic reactions:**
 - Addition
 - Elimination
 - Substitution
 - Re-arrangement.

(2) Alkanes

- IUPAC nomenclature
- Preparation- Wurtz reaction, Kolbe, Corey house
- Classification of Carbon atoms
- Physical properties
- Chemical properties
- Free radical substitution reaction

Unit – 2: Stereochemistry

13hrs

(3) Basics of Stereochemistry

- Introduction & Classification
- Isomerism
- **Optical Isomerism:**
 - Chirality/Asymmetry
 - Meso Compounds, Enantiomer & Diastereomer
 - Molecules with Two or more chiral centre
 - Optical activity & Specific rotation
 - Racemic mixture & Resolution
- **Projection & their Inter conversion :**
 - Wedge- Dash Formula
 - Fischer projection
 - Newmann
 - Sawhorse projection
- **Relative and Absolute configuration :**
 - D/L Configuration
 - R/S Configuration & CIP rules
- **Geometrical Isomerism:**
 - Cis – Trans
 - Syn – Anti
 - E-Z

Unit – 3: Cyclo alkanes and Conformational analysis

15hrs

(4) Cyclo alkanes

- **Nomenclature:**
 - Mono cyclic & Poly cyclic compounds
 - Spiro compounds
- **General methods of preparation :**
 - Freund
 - Perkin
 - Dieckmann
- **Physical & Chemical properties :**
 - Bayer's stain theory
 - Relative stability
- **Conformational Analysis of alkanes**
 - Relative stability with energy Diagram for
 - Ethane,
 - Butane,
 - Cyclohexane
 - Mono substituted Cyclohexane

Unit – 4: Gaseous State & Thermodynamics

15hrs

(5) Gaseous state

- Introduction
- General characteristics of gases
- **Gas laws :**

- Boyle's law
- Charles' law
- Gay-Lussac law,
- Avogadro law
- Kinetic Molecular theory
- Graham's law of diffusion
- Deviation from ideal behavior
- Vander Waal's equation
- Method of Liquefaction of gases

(6) Thermodynamics – 1

- Introduction
- System, surrounding, types of system
- Thermodynamic processes & Macroscopic properties
- State function & Path function
- Heat & work
- Zeroth law (Statement & Mathematical expression)
- First law (Statement & Derivation)
- **Thermo chemistry :**
 - Exothermic and endothermic reactions
- **Heat of reaction:** Combustion, Solution, Neutralization, Vaporization, Sublimation, Transition
- Hess law
- Bond dissociation energy

Unit – 5: Surface chemistry

17hrs

(7) Surface Phenomena and Catalysis

- Introduction
- Definitions: Adsorption, Absorption, Adsorbate, Adsorbent, Sorption, Desorption
- Types of Adsorption
- Difference between Physisorption & Chemisorption
- **Adsorption isotherm**
 - Langmuir Adsorption
 - Freundlich isotherm
- **Applications:**
 - Ion exchange : Water softening - deionization of H₂O
 - Medical application
- **Catalysis**
 - Introduction
 - Types of catalyst & catalysis
 - Characteristics of catalyst
 - Theory of catalysis
 - Acid base catalysis
 - Enzyme catalysis
 - Applications

(8) Basic Physical Properties

- Introduction
- **Classification of physical properties :**

- Additive property
- Constitutive property
- Additive - Constitutive property
- Molar Volume and Determination of Molar Volume
- **Definition, Equations and Applications of :**
 - Surface tension – Parachor
 - Dipole moment
 - Viscosity
 - Refractive Index

Text Books:

1. Bansal, Raj K. (2009, 5th edition) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8). (Unit-1,2 & 3)
2. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2009, 2nd edition) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 81-219-2978-4) (Unit-4&5)

Reference Books:

Organic Chemistry

1. Ahluwalia, V. K. (2011, 4thedition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. T.W. Graham Solomons (2011, 10thedition) *Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).
3. Clayden, Greeves, Warren & Wothers (2012, 2nd edition) *Organic Chemistry*. Oxford: Oxford University Press (ISBN: 9780199270293).
4. Agrawal, O. P. (2009, 46thedition) *Organic Chemistry: Reaction and Reagents*. Meerut: Krishna Prakashan Media (p) Ltd. (ISBN: 81-87224-65-7).
5. Morrison & Boyd (2009, 6thedition) *Organic Chemistry*. New Jersey: Pearson Education (ISBN: 978-81-7758-169-0).

Physical Chemistry

1. Negi, A. S.; Anand, S. C. (2007, 2ndedition) *A Textbook of Physical Chemistry*. New Delhi: New age International Publisher (ISBN: 81-224-2005-0).
2. Peter Atkins; Julio de Paula (2018, 11th edition) *Atkin's Physical Chemistry*. Oxford: Oxford University Press (ISBN: 978-0198814740).
3. ArunBahl; B.S. Bahl (2009, 1stedition) *Numerical Problems in Physical Chemistry*. New Delhi: S. Chand (ISBN: 81-219-3084-7).
4. Madan, R. L. (2011, 3rd edition) *Chemistry for degree student First year*. New Delhi: S. Chand (ISBN: 978-8121932301).

Semester – I		
Course Code	Course Title	Course Credit and hrs
19UCHCC103	Core Practical- 1:Inorganic/Analytical Chemistry Practical	2 Credits - 6 hrs / wk

Objectives:

To enable the students to

- Develop the skill to analyse and identify the inorganic salt.
- Develop skills in the scientific method of calibrating the glasswares.
- Enhance the skill of preparation and standardization of analytical solutions.
- Develop skills in understanding, planning and performing experiments for titrimetric analysis.

Laboratory Experiments

- Calibration of Volumetric Glassware (01)
- Preparation & Standardization of Analytical Solutions (Modes of Concentration)(06)
- Inorganic Qualitative Analysis – Two Radicals (Minimum- 10)
(CO_3^{2-} , O^{2-} , NO_2^- , NO_3^- , CrO_4^{2-} , $\text{Cr}_2\text{O}_7^{2-}$)
- Volumetric Analysis – Acid – Base & Redox titrations (Minimum-06)
- Gravimetric Analysis – Weight loss on Heating & LOD (Minimum-03 each)

Reference Books:

1. Brian S. Furniss (1989, 5th edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Hassner, A. (2012, 3rd edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
3. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989, 5th edition) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).

Semester – I		
Course Code	Course Title	Course Credit and hrs
19UCHCC104	Core Practical-2: Organic/Physical Chemistry Practical	2 Credits - 6 hrs / wk

Objectives:

To enable the students to

- Develop the skill to analyse and identify the organic salt.
- Built an ability for the determination of basic physical properties.
- Develop scientific skills in understanding, planning and preparing various organic reagents and solutions..

Laboratory Experiments

- Calibration of Instrument(Thermometer, Viscometer,Stalagmometer)(03)
- Determination of Basic Physical Properties:
 - Surface tension – Parachor (Minimum-02)
 - Viscosity (Minimum-02),
 - Adsorption(02)
 - Partial Molar Volume (Minimum-02)
- Preparation of Organic Reagents:Tollens, Nessler's, Neutral FeCl₃, Sod. cobaltnitrite (01)
- Preparation of Solution: Saturated sodium bicarbonate, 20%NaOH, 50%HCl (01)
- Organic qualitative analysis: (Mono functional) (Minimum-12)

Reference Books:

1. Jerry R. Mohrig (2010, 3rdedition) *Techniques in Organic chemistry*. London: W. H. Freeman &Company (ISBN: 1-4292-1956-4).
2. Svehla, G. (1979, 5thedition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).

Semester – II		
Course Code	Course Title	Course Credit and hrs
19UCHCC201	Core-3: Fundamentals of Chemistry- III	5 Credits - 5hrs / wk

Objectives:

To enable the students to

- Understand concepts of State of Matter, Co-ordination theory and Molecular orbital theory.
- Identify various possible errors and use significant figures in experiment reports.
- Develop skills in understanding and performing titrimetric analysis.
- Develop skills in the scientific manners of conducting experiments and drawing inferences to identify simple organic compounds.

Course content

Hours

Unit – 1: Co-ordination Chemistry

15hrs

(1) Elements of the First Transition Series

- Introduction & Electronic Configuration
- Reversal of energies of 3d and 4s orbital
- **Physical Properties:** Metallic, Crystal Structure, Conductivity, Density,
- Catalytic Properties & Tendency of Formation of Alloys
- **Periodic Properties:** Atomic and Ionic Radii, Ionization Potential and Oxidation states & its stability
- Magnetic & Spectral Properties
- Non-stoichiometric Defects & Interstitial Compounds

(2) Co-ordination Compounds

- Introduction ,Double salts
- Werner's co-ordination theory
- Ligand & its types
- Co-ordination Compounds
- Nomenclature
- Chelating ligand & Chelates
- Application of Co-ordination compounds
- Isomerism in complexes**
- Werner's classification
- Structural & Geometrical Isomerism
- Structure & Complex -Co-ordination No.4 & 6

Unit – 2: Molecular Orbital Theory

15hrs

- Characteristics of MOT
- Comparison between VBT & MOT
- Linear Combination of Atomic Orbital
- Bond order
- **Difference between :**
 - BMO & ABMO
 - Gerade & Ungerade

- Electronic configuration & Energy level diagram of homo and hetero nuclear diatomic molecules H₂, He₂, Li₂, Be₂, B₂, C₂, N₂, O₂, F₂, Ne₂, NO & CO
- Determination of wave function & wave equation
- Determination of Potential energy of H₂ and H₂⁺
- Hybridization and Construction of Hybrid orbital
- Derivation of Wave equation and wave function of : sp, sp², sp³

Unit – 3: Solid State

17hrs

(4) Ionic solids

- Introduction
- Characteristics of Ionic solids
- Born Haber Cycle
- Max Born Equation
- Limiting radius ratio
- Relation between radius ratio, coordination number and crystal structure
- **Derivation of r^+/r^- ratio in crystal lattice:**
 - Trigonal
 - Squareplanar
 - Body centered
 - Tetrahedral
- **Crystal structure of ionic solids:**
 - HCP
 - BCP
 - FCC
- **Crystal structure of ionic solids :**
 - AB type - CsCl and ZnS (Zinc blend)
 - AB₂ type - CaF₂ and TiO₂
- **Defects in Ionic Crystal Lattice:**
 - Stoichiometric and Non stoichiometric

(5) Crystalline state

- Introduction
- Difference between crystalline and amorphous solid
- Crystal and crystallography
- Three laws of crystallography
- Space lattice ,Unit cell & Bravais lattices
- Type of cubic lattice and inter planar spacing
- **X- rays Diffraction:**
 - Brags equation
 - Experimental methods(Rotating crystal and Powder method)
 - Structure of Rock salt (NaCl) and Sylvin (KCl)
- **Liquid Crystals:**
 - Introduction
 - Definition
 - Classification of liquid crystals
 - Smectic
 - Nematic
 - Cholesteric
 - Disc shape

(6) Errors and Statistics

- Introduction to Errors and Mistake
- **Classification of errors :**
 - Determinate and indeterminate errors
 - Operational and personal error
 - Instrumental errors
 - Reagent errors
 - Additive & proportional error
- Accuracy and precision with their difference
- Minimization of error
- **Calibration of Instruments :**
 - Blank measurement
 - Independent method
 - Parallel method
 - Standard addition method
- Explanation of Significant figure and its laws with complete interpretation
- Mean and standard deviation , variance and coefficient of variance
- Absolute error and relative error, mean value, deviation and relative mean deviation.
- Gaussian curve and its explanation
- Importance of Q – test and T -test (Student T test)
- Example on errors, significant figures , Q test and T test

(7) Organic Qualitative Analysis

- Introduction to nature of organic compounds
- Unsaturation test
- FeCl_3 test
- Elemental analysis
- Functional group tests
- Determination of Physical constant
- Derivatization

Unit – 5: Titrimetric Analysis

15hrs

(8) Complexometric&Non aqueous Titrations

- **Complexometric titration**
- Method of preparation of standard E.D.T.A. Solution
- Velcher's law explanation of $\text{pM} \rightarrow \text{EDTA vol.}$, Graph with stability constant value.
- **Types of EDTA Titration :**
 - Direct Titration
 - Back Titration
 - Substitution Titration
 - Alkalimetry titration mixture with the help of masking and demasking agent
- Principle of metal ion indicator
- **Structure , Use and characteristics of various indicators :**
 - EBT

- Calcon
- Muroxide
- **Precipitation titration**
 - Argentometric titration
 - Mohr's method
 - Fajan's method
 - Volhard method

(9) Water Analysis

- Introduction, Total solid & Volatile solid
- Total Dissolved Solid, Total Suspended Solid
- Non filterable & Filterable solid & Non filterable volatile Solid
- Acidity, Alkalinity & Turbidity
- Hardness of Water & EDTA methods for determination of hardness of water
- Chemical oxygen demand (COD)
- Biological oxygen demand (BOD)
- Dissolve oxygen (DO)

Text Books:

1. Puri, B. R.; Sharma, L. R. & Kalia, K. C. (2017, 33rd edition) *Principles of Inorganic Chemistry*. New Delhi : Milestone (ISBN No. 978-8192143330) (Unit-1,2 & 3)
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3. Peter Atkins, Tina Overton, Jonarthan Rourke, Mark Weller & Fraser Armstrong (2010, 5th edition) *Inorganic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-959960-8).

Analytical Chemistry

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2. Sharma, B. K. (2014) *Instrumental Method of Chemical Analysis*. Meerut: GOEL publishing House (ISBN: 978-81-8283-099-8).
3. Christian, Gary D.; Dasgupta, Purnendu K.; S. Chug, Kevin A. (2007, 6th edititon) *Analytical Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 978-81-265-1113-6).

Semester – II		
Course Code	Course Title	Course Credit and hrs
19UCHCC202	Core-4: Fundamentals of Chemistry- IV	5 Credits - 5hrs / wk

Objectives:

To enable the students to:

- Understand & reproduce the nomenclature, learn physical & chemical properties and plan the preparation of Alkenes, Alkynes, Dienes, Alcohols, Phenols, Ethers and Epoxide, Alkyl halide and Aryl halide
- Use concepts of chemical kinetics for making predictions and explanations of type, rate and order of reactions.
- Develop understanding regarding aromatic behavior of organic compounds and their typical chemical properties.
- Understand the concept of Solutions, Colloidal state & Chemical equilibrium.
- Develop skills in the scientific method of conducting experiments and determining basic properties of chemical entities.

Course content **Hours**

Unit – 1: Chemistry of Hydrocarbons **15hrs**

(1) Aromatic Hydrocarbons

- Structure of benzene & toluene
- **Electrophilic aromatic substitution with its mechanism:**
 - Nitration
 - Sulphonation
 - Halogenation
 - Friedal-Craft reactions
 - Alkylation
 - Acylation
- Directing effects of the groups
 - o-p directing
 - m-directing
- **Aromaticity**
 - Huckel rule
 - Benzenoid and non benzenoid structures
 - Criteria for Aromatic, Non-Aromatic and Anti-Aromatic compounds

(2) Alkenes, Alkynes, Dienes

- **Alkenes :**
 - Nomenclature
 - Preparation by elimination :
 - Dehydration of alcohol
 - Dehydrohalogenation of alkyl halide
 - Physical properties
 - Chemical properties
 - Polymerization
 - Markovnikov's – Anti Markovnikov's – Saytzeff rule

- **Alkynes :**
 - Preparation
 - Physical & Chemical properties
 - Polymerization
- **Dienes :**
 - Classification
 - Preparation
 - Diels – Alder reaction
 - Addition reaction (1:2 & 1:4)for 1,3 butadiene

Unit – 2: Functional Group Chemistry

17hrs

(3) Alkyl halide and Aryl halide

- **Alkyl halide**
 - Nomenclature, Classification, Preparation
 - SN^1 & SN^2 reaction mechanism
 - E^1 & E^2 reaction mechanism
 - Substitution and elimination reaction of alkyl halide
- **Aryl halide**
 - Nomenclature
 - Classification
 - Preparation
 - Nucleophilic aromatic substitution with reactivity & orientation
 - Benzyne , Elimination – Addition reaction
 - Relative reactivity of Alkyl halide, Aryl halide, Vinyl halide

(4) Alcohols, Phenols, Ethers and Epoxide

- **Alcohols**
 - Nomenclature
 - Classification
 - Physical properties
 - Chemical properties
 - Reactions of O-H bond fission
 - Reactions of C-O bond fission
- **Phenols**
 - Nomenclature
 - Classification
 - Industrial Production of Phenol
 - Physical Properties
 - Chemical Properties
 - Reactions of O-H group
 - Reactions of aromatic ring
- **Ethers :**
 - Nomenclature
 - Classification
 - Preparation
 - Physical properties
 - Chemical properties
- **Epoxides:**

- Nomenclature
- Preparation
- Chemical properties

Unit – 3: Properties of Solution and Chemical Kinetics

13hrs

(5) Dilute Solutions and Colligative Properties

- Introduction
- Types of solution
- Factors affecting on solution
- **Colligative properties**
 - Raoult's law and its derivation
 - Determination of molecular mass from lowering of vapour pressure by different methods
 - Boiling point elevation
 - Relation between boiling point elevation & lowering of vapour pressure
 - Determination of molecular mass from boiling point elevation by different methods
 - Depression in freezing point
 - Determination of molecular mass from Depression in freezing point by different methods
- Colligative properties of electrolytes
- Numericals

Unit – 4: Chemical Equilibrium & Chemical Kinetics

15hrs

(6) Chemical Equilibrium

- Introduction
- Nature, criteria & Characteristics of chemical equilibrium
- Law of active masses
- Thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x .
- Heterogeneous and homogeneous equilibrium
- Le Chatelier's principle, Equilibrium constants and their quantitative dependence on temperature, pressure and concentration
- Numericals

(7) Chemical Kinetics

- Introduction
- Order and molecularity of reaction
- Derivation, Characteristics, Half life time & Examples of
 - Zero order reaction
 - First order reaction
 - Second order reaction
 - Pseudo Unimolecular reaction
- Method for determining the order of reaction:
 - Graphical method
 - Ostwald's isolation method
 - Method of half-life period
 - Integration method

- Energy of Activation and catalysis
- Numericals

Unit – 5: Colloidal State

15hrs

- Introduction : Classification of colloidal solutions
- Characteristics of hydrophilic and hydrophobic sols
- Stability of colloids and origin of charge on colloid particles
- Emulsification and de-emulsification
- Preparation of colloidal solution :
 - Lyophilic solution
 - Lyophobic solution
- Preparation methods:
 - Condensation method:
 - Double decomposition
 - Hydrolysis
 - Reduction
 - Oxidation Exchange of solvent
 - Controlled condensation
 - Change of physical state in short.
 - Dispersion methods:
 - Bredig's Arc method
 - Grinding
 - Peptization.
- Purification of colloidal solution :
 - Dialysis
 - Ultra filtration
 - Ultra centrifuging
- Stability of colloids solution
- Properties of colloidal solutions:
 - Optical properties
 - Tyndall effect
 - Brownian effect
- Electrical properties: Electrical Double Layer Charge, Electrophoresis, Electro-osmosis.
- The Protective colloid (gold number)
- Applications

Text Books:

1. Bansal, Raj K. (2009, 5th edition) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8). (Unit-1,2 & 3)
2. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2010) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 81-219-2978-4) (Unit-4&5)

Reference Books

Organic Chemistry

1. Ahluwalia, V. K. (2011, 4thedition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. T.W. Graham Solomons (2011, 10thedition) *Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).

3. Clayden, Greeves, Warren & Wothers (2012, 2nd edition) *Organic Chemistry*. Oxford: Oxford University Press (ISBN: 9780199270293).
4. Agrawal, O. P. (2009, 46th edition) *Organic Chemistry: Reaction and Reagents*. Meerut: Krishna Prakashan Media (p) Ltd. (ISBN: 81-87224-65-7).
5. Morrison & Boyd (2009, 6th edition) *Organic Chemistry*. New Jersey: Pearson Education (ISBN: 978-81-7758-169-0).

Physical Chemistry

1. Negi, A. S.; Anand, S. C. (2007, 2nd edition) *A Textbook of Physical Chemistry*. New Delhi: New age International Publisher (ISBN: 81-224-2005-0).
2. Peter Atkins; Julio de Paula (2018, 11th edition) *Atkin's Physical Chemistry*. Oxford: Oxford University Press (ISBN: 978-0198814740).
3. Arun Bahl; B.S. Bahl (2009, 1st edition) *Numerical Problems in Physical Chemistry*. New Delhi: S. Chand (ISBN: 81-219-3084-7).

Semester – II		
Course Code	Course Title	Course Credit and hrs
19UCHCC203	Core Practical -3: Inorganic/Analytical Chemistry Practical	2 Credits - 6hrs / wk

Objectives:

To enable the students to

- Develop the skill to analyse and identify the inorganic salt.
- Built an ability to perform titrimetric analysis of various type of metal ion which includes complexometry and iodometry.
- Construct the skill for the complete analysis of water.

Laboratory Experiments

- Inorganic Qualitative Analysis – Two Radicals (Minimum –12)
(S⁻², SO₃⁻², SO₄⁻², PO₄⁻³, Cl⁻, Br⁻, I⁻)
- Titrimetric Analysis:(Minimum - 06)
 - Complexometric(Cu/Zn/Ni/Mg)
 - Iodometric&Iodimetric
- Water Analysis:(Minimum - 08)
(TDS, Cl⁻, Ca& Mg, DO, Total Alkalinity, Acidity, Turbidity, Density, Conductance, pH)

Reference Books:

1. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (5th1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
2. Svehla, G. (1979, 5thedition) *Textbook of macro and semi micro qualitative analysis*. London: Longman Publishing group (ISBN: 0-582-44367-9)

Semester – II		
Course Code	Course Title	Course Credit and hrs
19UCHCC204	Core Practical-4: Organic/Physical Chemistry Practical	2 Credits - 4hrs / wk

Objectives:

To enable the students to

- Measure the rate and order of primary elementary reaction.
- Perform basic food analysis.
- Estimate the amount of organic compound in given sample.

Laboratory Experiments

- Chemical Kinetics (Minimum-06)
 - First & Second Order kinetics
- Organic Qualitative Analysis: Mono-functional (Minimum-12)
- Organic Estimations (Minimum-04)
- Food Analysis (Minimum-02)

Reference Books:

1. Brian S. Furniss (1989, 5th edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Hassner, A. (2012, 3rd edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
3. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (5th 1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
4. Jerry R. Mohrig (2010, 3rd edition) *Techniques in Organic chemistry*. London: W. H. Freeman & Company (ISBN: 1-4292-1956-4).

Semester – III		
Course Code	Course Title	Course Credit and hrs
19UCHCC301	Core-5: Inorganic Chemistry	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Understand elementary concepts of wave mechanics.
- Develop skill to predict properties of f- block elements.
- Describe the phenomena of magnetism, types of magnetism and Gouy's method.
- Predict Magnetic behavior of transition metal complexes, splitting of d-orbital and transition in metal complexes.
- Understand & write the preparation & properties of organometallic compounds and their applications.

Course Content

Hours

Unit-I: Introduction to Quantum Chemistry

12 hrs

(1) Wave Mechanics

- Operators, Algebra of operators:
 - Addition and subtraction
 - Multiplication of operators
- Communicative properties:
 - Linear operator
 - Commutator of operators
 - Laplacian operator
 - Momentum operator
 - Hamiltonian operator
- Particle in one dimensional box
- Wave function and energy of particle in one dimension box
- Energy levels, normalization of Ψ and orthogonality of Ψ .
- Characteristics of wave function
- Utility of the particle in a box model
- Particle in three dimensional box
- Degeneracy
- Wave function and energy for a particle moving in a rectangular box
- Wave equation for a hydrogen atom
- Separation of variables
- Numericals

Unit-II: Chemistry of Elements - II

12 hrs

(2) Lanthanides and Actinides

- Electronic configuration
- Oxidation states

- Color & Magnetic properties
- Lanthanide contraction
- Separation of lanthanides (ion exchange method only)
- Applications

(3) Nuclear Chemistry:

- Radioactivity
- Types Of Radiations
- Properties Of Radiations
- Types Of Radioactive Decay
- Rate Of Radioactive Decay and half-Life
- Nuclear Reactions : Fission & Fusion Reactions

Unit-III: Multi electron system

10hrs

(4) Multi electron system

- Concept of spectral terms and term symbols.
- S-S coupling, L-L coupling, L-S coupling, J-J coupling and L-S coupling with vector diagram.
- Derivation of spectral term symbol for p^1 , p^2 , p^3 , & d^1 to d^9 .
- Micro states: definition, calculation and derivation of microstates for p^1 , p^2 , d^1 & d^2 (Pigeonhole diagram).
- Hund's rules for the determination of ground state spectral term.

Unit-IV: Magneto chemistry and organometallic compounds

12 hrs

(5) Magneto chemistry

- Introduction (Magnetic field, Magnetic pole, Intensity of magnetization).
- Magnetic induction.
- Permeability, Intensity of Magnetism, Magnetic susceptibility, Molar magnetic susceptibility.
- Magnetic behavior: Diamagnetism, Paramagnetism, Ferromagnetism and Anti ferromagnetism.
- Effect of temperature on magnetic behavior of substances.
- Derivation of equation for total angular magnetic momentum and diamagnetic momentum.
- Determination of magnetic susceptibility by Gouy's method.
- Applications

(6) Organometallic Compounds

- Introduction
- Classification based on nature of M-C Bond.
- Trans effect for Isomerism in OMC, EAN rules & Numerical
- Preparation, Properties and uses of Organolithium (Ph-Li & Bu-Li), Organomagnesium (Grignard), Organocopper (Gilman), Organoaluminium (AIP, Ziegler-Natta).

Unit-V: Crystal field Theory

14hrs

(7) CFT – I

- Introduction
- Concept of crystal field theory
- Splitting of d-orbital in octahedral and tetrahedral crystal field with CFSE concept.
- Factors affecting splitting energy.
- Weak field and strong field ligand.
- High spin and low spin complexes with pairing energy.
- Magnetic behavior of transition metal complexes.
- Orbital angular momentum contribution to magnetic momentum of complexes.
- Examples based on CFSE, Pairing energy and magnetic momentum.

(8) CFT – II

- Jahn-Teller effect: Statement and explanation.
- Tetragonal distortion with example.
- Splitting of d-orbital in square planar complexes with examples.
- Hole formalism.
- Splitting of d and f ground terms (using Hole formalism).
- Orgel Diagram of d and f states.
- Selection rules for d-d transition.
- Types of electronic transition in metal complexes.
- Application of Orgel Diagram (Spectra of some complexes)

Text book:

1. Puri, B. R.; Sharma, L. R. & Kalia, K. C. (2017, 33rd edition) *Principles of Inorganic Chemistry*. New Delhi : Milestone (ISBN No. 978-8192143330) (Unit-1 to 4)
2. Mehrotra, R. C. (2007). *Organometallic chemistry*. New Age International (Unit-5)

Reference Books:

1. Madan, R. L. (2011, 3rd edition) *Chemistry for degree student First year*. New Delhi: S. Chand (ISBN: 978-8121932301).
2. Lee, J. D. (2002, 5th edition) *Concise Inorganic Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 0-632-05293-7).
3. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller & Fraser Armstrong (2010, 5th edition) *Inorganic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-959960-8).

Semester – III		
Course Code	Course Title	Course Credit and hrs
19UCHCC302	Core 6: Analytical Chemistry	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Illustrate & Perform solvent extraction methods.
- Understand concept of EMF, types of cell and EMF series.
- Understand & perform the conductometric titration and its applications.
- Analyzed and describe optical activity & optical isomerism
- Understand the principles and applications of electro analytical methods.

Course Content

Hour

Unit- I: Electro analytical methods - I

14 hrs

(1) EMF

- Introduction: Electrochemistry, electrochemical cell, electrolytes, oxidation, reduction, anode, cathode, half-cell, cell potential, concentration cell
- Reversible and irreversible cell
- Nernst equation and its applications
- Calculation of equilibrium constant
- EMF series
- Relation among G, H and K
- Types of Electrodes and uses
- Numericals

(2) Polarography

- Introduction
- Principle
- Instrumentation, working & calibration
- Factors affecting the limiting currents, cells
- Forms of waves and half wave potentials
- Applications

Unit-II: Electro analytical methods -II

12 hrs

(3) Conductometry

- Electric transport, conductance in metals and in electrolyte solution
- Specific conductance, equivalent conductance
- Importance of conductivity electrodes and platinization of electrodes
- Variation of specific conductance with dilution as well as area of cross section of dip type electrode and distance between two plates of electrodes etc.
- Kohlrauschlaw and its importance, cell constant and its importance.
- Conductometric Titration :
 - Strong acid - strong base
 - Strong acid - weak base

- Weak acid – strong base
- Weak acid – weak base
- Mixture of strong acid + weak acid - strong base
- Precipitation Titration :
 - $\text{AgNO}_3 - \text{NaCl}$
 - $\text{BaCl}_2 - \text{K}_2\text{SO}_4$
 - $\text{Ba}(\text{OH})_2 - \text{MgSO}_4$
- Replacement Titration :
 - Salt of weak acid – strong acid
 - Salt of weak base – strong base
- Degree of hydrolysis and Hydrolysis constant
- Determination of solubility and solubility product of sparingly soluble salt, for the measurement of conductivity
- Numericals

Unit-III: Opto-analytical Methods - I

12 hrs

(4) Polarimetry

- Introduction
- Plane polarized light
- Optical activity
- Types of molecules analysed by polarimeter
- Theory of optical activity
- Polarimeter- Instrumentation, Working, Calibration & Application

(5) Visible Spectrophotometry and Colourimetry

- Introduction, Instrumentation, Working & Calibration
- Growth Draper law, Lambert's Law, Beer's Law, Lambert's-Beer's Law and derivation, application and deviation from Lambert's Law
- Spectrophotometric titration with graph and proper explanation
 - Deficit of absorbance by product and titrant
 - Deficit of absorbance by product and reagent
 - Deficit of absorbance by reagent and titrant
 - Deficit of absorbance by product only

Unit-IV: Opto-analytical Methods - II

10 hrs

(6) Refractometry

- Introduction
- Abbe refractometer- Instrumentation, Working & Calibration
- Optical exaltation
- Applications

(7) Flame Photometry

- Introduction,
- General principles of flame photometry,
- Instrumentation, Working & Calibration,

- Effect of solvent in flame photometry,
- Interferences in flame photometry,
- Limitations of flame photometry
- Applications

Unit-V: Analytical Separation Techniques

(8) Separation involving Solvent Extraction

12 hrs

- Introduction, Nature of the separation process
- Separation by precipitation
- Separation based on control of acidity
- Sulphide separations
- Other inorganic precipitant
- Organic precipitant
- Separation of constituents present in trace amounts
- Separation by electrolytic precipitation
- Extraction methods
- Sequence of the extraction process
- Extraction technique
- Applications of extraction procedures
- Ion exchange separation
- Numericals

Text Books:

1. Sharma, B. K. (2014) *Instrumental Method of Chemical Analysis*. Meerut: GOEL publishing House (ISBN: 978-81-8283-099-8). (Unit-1 to 5)

Reference Books:

1. Fifield, F. W., & Kealey, D. (2000, 5th edition). *Principles and practice of analytical chemistry*. (ISBN: 978-0632053841) Hoboken: Blackwell Science.
2. Douglas A. Skoog, West, Holler, Crouch (2004, 8th edition) *Fundamental of Analytical Chemistry*. Mexico: Thomson-Brooks/Cole (ISBN: 81-315-0051-9).
3. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2020, 28th edition) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 978-9352836093)
4. Christian, Gary D.; Dasgupta, Purnendu K.; Schug, Kevin A. (2007, 7th edition) *Analytical Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 978-81-265-1113-6).

Semester – III		
Course Code	Course Title	Course Credit and hrs
19UCHCC303	Core-7: Petroleum and Petrochemicals	2 Credits - 2 hrs / wk

Objectives:

To enable the students to

- Understand petroleum and its products.
- Classify petroleum products
- Study process flow diagram for manufacturing of C1 to C4 compounds.

Course Content

Hours

Unit-I: Introduction of Petroleum & Petrochemicals

05 hrs

- Occurrence
- Color
- Origin of petroleum
- Classification of petroleum
- Composition of petroleum
- Important petroleum products
- Feed stock for petrochemicals

Unit-II: Processing Crude Petroleum and Petroleum Product Analysis

05 hrs

- Overview of treatment methods for petroleum Desalting of Petroleum
- Fractional distillation of crude petroleum
- Cracking and Reforming of petroleum
- Petroleum product analysis
- Cuts and composition of fractional distillation

Unit-III: Chemicals from C1 Compounds and C2 Compounds

07 hrs

- Manufacturing of C1 hydrocarbons
 - Methanol
 - Hydrogen cyanide
 - Carbon disulphide
- Manufacturing of C2 Hydrocarbons
 - Ethyl chloride
 - Ethanol
 - Ethylene Glycol
 - Ethylene Oxide
 - Acetic Acid
 - Styrene
 - Vinyl acetate

Unit-IV: Chemicals from C3 Compounds and C4 Compounds

08 hrs

- Manufacturing of C3 hydrocarbons

- Isopropanol
- Cumene
- Polypropylene
- Glycerin
- Acrylonitrile
- Propylene oxide
- Acrylic Acid
- Bis-phenol
- Manufacturing of C4 Hydrocarbons
 - Butadiene
 - Isobutane
 - Butanol
 - Maleic Anhydride
 - Adipic Acid

Unit-V: Aromatic compounds, Syngas and SNG Production

05 hrs

- Manufacture of the BTX & Naphthalene
- Linear alkyl benzenes and their Sulphonates
- Syngas production by steam reforming:
 - From natural gas and from naphtha.
- SNG production:
 - From naphtha and from via partial oxidation

Text books:

1. Bhaskara Rao, B.K., (2000) *A Text on Petrochemicals*, Khanna Publishers (ISBN: 978-81-7409-044-7).
2. SukumarMaiti, (2002, 2nd edition) *Indroduction to Petrochemicals*, 2nd Edition, Oxford and IBH Publishers (ISBN: 9788120415553).

Reference Books:

3. Waddams, A. L. (1969, 2nd edition). *Chemicals from petroleum*. ELBS, London. (ISBN: 978-0820601601).

Semester – III		
Course Code	Course Title	Course Credit and hrs
19UCHCC304	Core-5: Inorganic Chemistry practical	2 Credits - 5 hrs / wk

Objectives:

To enable the students to

- Identify unknown inorganic mixture
- Develop skill to prepare and purify inorganic complexes.
- Develop skill to determine concentration of metal ion in the given solution.

Laboratory experiments:

- **Inorganic Qualitative Analysis – Four radicals (12)**
- **Advanced Volumetric Analysis (04)**
 - To determine the amount of Mg^{+2} and Pb^{+2} in the given solution containing a mixture of Mg^{+2} and Pb^{+2} using 0.01M EDTA solution.
 - To determine the amount of Ca^{+2} and Zn^{+2} in the given solution containing a mixture of $CaCl_2 \cdot 2H_2O$ and $ZnCl_2$ using 0.01M EDTA solution.
 - To determine the amount of Ni^{+2} in the given $NiSO_4 \cdot 7 H_2O$ solution using 0.01 M EDTA solution (Back titration).
 - To determine the amount of Bi^{+3} ions in the given $Bi(NO_3)_3$ solution with the help of 0.01M EDTA.
- **Advanced Inorganic preparation and purification (04)**
 - Preparation of tetra amine cupric sulphate from copper sulphate.
 - Preparation of hexamine nickel (II) chloride from $NiCl_2$.
 - Preparation of hexathioureaplumbus nitrate from $Pb(NO_3)_2$.
 - Preparation of copper (II) acetylacetonate from $CuCl_2$.
- **Gravimetric Estimation (04)**
 - Estimation of Ba as $BaSO_4$
 - Estimation of Fe as Fe_2O_3
 - Estimation of Ni as $Ni(DMG)_2$
 - Estimation of Al as Al_2O_3
- **Inorganic Pharmaceutical practicals (02)**
 - Preparation of boric acid from borax
 - Preparation of alum from aluminum sulphate

Text books

1. AI, V. (1996). *Vogel's qualitative inorganic analysis*.

Reference Books:

1. Puri, B. R.; Sharma, L. R. & Kalia, K. C. (2017, 33rd edition) *Principles of Inorganic Chemistry*. New Delhi : Milestone (ISBN No. 978-8192143330)

Semester – III		
Course Code	Course Title	Course Credit and hrs
19UCHCC305	Core practical - 6: Analytical Chemistry	2 Credits - 5 hrs / wk

Objectives:

To enable the students to

- Develop skill to determine concentration of unknown concentration of given solution by different instrumental methods.
- Get idea of basics of food analysis and adulteration.

List of Practical:

➤ Conductometry (04)

- To determine normality and gms/lit of xNHCl and also determine specific conductance by conductometry.
- To determine normality and gms/lit of the mixture of HCl+CH₃COOH by conductometry.
- To determine the normality of weak acid by conductometry.
- To determine the concentration of Ni⁺² using 0.1M EDTA solution by conductometry.

➤ Colourimetry (05)

- Find out the amount of Ni⁺² in the given solution by colorimetry method.
- Find out the amount of Fe⁺³ in the given solution by colorimetry method.
- To determine Lambert-beer law in given solution.
- To determine the composition of binary mixture containing KMnO₄ & K₂Cr₂O₇.
- To determine amount of Paracetamol in given tablet by colorimetry method.

➤ Refractometry (05)

- To determine specific refractivity and molecular refractivity of given pure liquid A, B, C, D.
- To determine specific refractivity and molecular refractivity of Glycerin (10%, 5%, 2.5%) and unknown Glycerin solution.
- To determine molar refractive index of given salt.(NaCl)
- To study the variation of refractive index with composition of given liquid and also determine composition of unknown mixture.
- To determine the percentage composition of binary mixture.

➤ Polarimetry (04)

- To determine specific rotation of three different concentration (10%, 5%, 2.5%) of dextrose solution. From graph find out the unknown concentration.
- Study the inversion rate of sugar in presence of 1N HCl and determine the rate of reaction.
- To determine the specific rotation of D - Amino acid.
- To determine the specific rotation of L - Amino acid.

➤ Solvent Extraction (03)

- To separate mixture of urea and salt.

- To separate benzoic acid from toluene.
- To separate chlorophyll from green leaf.
- **Food Analysis (02)**
 - To determine the amount of calcium in given milk sample.
 - To determine the amount of protein in given milk sample.
- **Food Adulteration (01)**
 - To check out the adulteration of the given food sample

Text book:

1. Parsania P.H., Karia F.,(2004, 1st edition) Experiments in physical chemistry,Neminath Printers Rajkot

Reference Book:

1. Wilson, J. M., Newcombe, R. J., &Denaro, A. R. (2013, 2nd edition). *Experiments in physical chemistry*. Elsevier (ISBN: 9781483186191)

Semester - III		
Course Code	Course Title	Course Credit and hrs
19UCHCC306	Core Practical –7: Petroleum Analysis	1 Credits - 2 hrs / wk

Objectives:

To enable the students to

- Determine analysis of smoke point, viscosity and fire point for petroleum products

Laboratory experiments:

- To determine the penetration number of given Bituminous sample.
- To determine the softening point of Bituminous material (Grease).
- To determine the softening point of Bituminous material (Wax).
- To determine the smoke point of light petroleum products.
- To determine the kinematic viscosity of an oil sample using Redwood viscometer.
- To determine the kinematic viscosity of an oil sample using Saybolt viscometer.
- To determine flash point by using Cleveland open-cup apparatus for the following compounds: (2)
 - Diesel
 - Kerosene
- To determine fire point by using Cleveland open-cup apparatus for the following compounds:(2)
 - Diesel
 - Kerosene
- To determine the % moisture present in a given sample of liquid petroleum by Dean & Stark's method.
- Determination of Cloud and Pour point of heavy petroleum product.
- To determine the density of given petroleum sample.

Text books

1. Gokhale, N. S. (2008, 1st edition). *Practical finite element analysis*. Finite to infinite (ISBN: 978-8190619516).

Reference Books:

1. Waring, B; (2016, 2nd edition) *Practical Optimization of Petroleum Production Systems* (ISBN: 978-1523692323).

Semester – IV		
Course Code	Course Title	Course Credit and hrs
19UCHCC401	Core-8: Organic Chemistry	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Describe preparations and chemical properties of various functional groups.
- Predict & describe mechanism of different name reactions.
- Give the applications of various reagents.
- Write the synthesis and uses of different dyes, perfumes and explosives.

Course Content

Hours

Unit-I: Chemistry of carbonyl compounds

14 hrs

(1) Aldehyde and Ketone

- Nomenclature, preparation of aldehyde by
 - Reduction methods (Rosenmund, Stephen)
 - Oxidation method (Etard, Sarett using PCC and PDC)
- Preparation of ketone:
 - Friedel-Craft Acylation
 - Organometallic compounds of Li and Cd
- Physical properties of aldehyde and ketone
- Chemical properties of aldehyde and ketone
- Nucleophilic addition reaction
 - Reaction with NaHSO₃
 - Acetal and ketal formation
 - Cyanohydrin formation
 - Oxime formation
 - Hydrazone formation
 - Reaction with Grignard reagent
- Some important reactions
 - Aldol condensation
 - Crossed aldol condensation
 - Cannizzaro reaction
 - Clemmensen reduction
 - Wolff-Kishner reduction

(2) Active Methylene Compounds

- Introduction
- Keto-enol tautomerism in acidic & basic medium
- Preparation of Ethyl acetoacetate by Claisen condensation
- Physical & chemical properties
- Various Synthesis from EAA
 - Monocarboxylic acid

- Dicarboxylic acid
- α,β -Unsaturated acid
- Diketone
- Ketone
- Heterocyclic compounds

Unit-II: Carboxylic acid

10 hrs

(3) Carboxylic acid and its derivatives

- Nomenclature
- Synthesis of monocarboxylic acid
 - Oxidation of primary alcohol
 - Hydrolysis of acid derivatives
- Physical properties
- Acidity of carboxylic acid
- Effect of substituent on acidity of carboxylic acid
- Chemical properties
 - Hell-Volhard-Zelinsky reaction
 - Formation of acid derivatives like acid chloride, acid anhydride, ester and amide
- Reactions of acid derivatives
- Hydrolysis of ester
 - Acidic
 - Basic
- Trans Esterification

Unit-III: Nitrogen containing Compounds

12 hrs

(4) Amines, cyanide, isocyanide and nitro compounds

- **Amines**
- Nomenclature, Classification
- Preparation of primary amines:
 - Reduction of nitro compounds
 - Reaction of ammonia with alkyl halide
 - Hoffmann bromamide reaction
- Physical properties
- Chemical properties:
 - Reaction with aryl sulfonyl chloride
 - Reaction with acid chloride
 - Reaction with alkyl halide
- Hinsberg test for identification / isolation of amines
- Diazotization and reaction of diazonium salt
- **Cyanide, Isocyanide and Nitro compounds**
 - Introduction
 - IUPAC nomenclature

- Preparation
- Physical properties and Chemical properties

Unit-IV: Reaction, Rearrangement and Reagent

12 hrs

(5) Organic Name Reactions

- Principle, mechanism, and applications of
 - Reformatsky reaction
 - Baeyer-Villiger oxidation
 - Vilsmeier-Haack reaction
 - Wittig reaction
 - Appel reaction
 - Michael addition

(6) Rearrangement and Reagents

- Principle, mechanism and applications of
 - Fries
 - Beckmann
 - Benzil-Benzilic acid
 - Pinacol-Pinacolone rearrangement
- Preparation, properties, and applications of
 - LiAlH_4
 - NaNH_2
 - N- bromosuccinamide (NBS)
 - NaBH_4

Unit-V: Chemistry of synthetic molecules

12 hrs

(7) Dyes

- Introduction, Classification
- Synthesis and uses of following dyes
 - Alizarin
 - Indigo
 - Malachite green
 - Congo red
 - Methyl orange
 - Crystal violet
 - Diamond black -F

(8) Explosives

- Synthesis and uses of following
 - RDX
 - PETN
 - TNT

(9) Perfumes:

- Musk Xylene
- Musk Ketone
- MuskAmbrette

(10) Polynuclear aromatic Hydrocarbons

- Introduction
- Synthesis and chemical properties and uses of:
 - Biphenyl
 - Diphenyl methane
 - Naphthalene
 - Anthracene.

Text book:

1. Bansal, Raj K. (2009, 5th edition) A Textbook of Organic Chemistry. New Delhi: New Age International (ISBN: 978-81-224-2025-8). (Unit-1to5)

Reference Books:

1. Ahluwalia, V. K. (2011,5th edition) Organic Reaction Mechanism. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. T.W. Graham Solomons (2011, 10th edition) Organic Chemistry. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).
3. Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2012, 2nd edition). Organic chemistry. Oxford: Oxford University Press (ISBN: 9780199270293).
4. Agrawal, O. P. (2009, 46th edition) Organic Chemistry: Reaction and Reagents. Meerut: Krishna Prakashan Media (p) Ltd. (ISBN: 81-87224-65-7).
5. Morrison & Boyd (2009, 6th edition) Organic Chemistry. New Jersey: Pearson Education (ISBN: 978-81-7758-169-0).

Semester – IV		
Course Code	Course Title	Course Credit and hrs
19UCHCC402	Core-9: Physical Chemistry	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Understand the change of heat between system and surrounding.
- Illustrate entropy change and its measurement.
- Predict effect of temperature and pressure on chemical potential.
- Understand potential change in different type of titrations using different electrode.
- Write the photochemical reaction and its application.

Course Content

Hours

Unit -I: Thermodynamic

10 hrs

(1) Thermodynamics – 2

- Introduction
- Reversible reactions, Spontaneous reactions
- Statements of second law
- Cyclic process
- Concept of entropy
- Determination of entropy of solid, liquid, gas
- Effect of temperature and pressure on entropy
- Entropy of mixing of gases
- Nernst heat theorem
- Statement of third law
- Tests of third law
- Residual entropy
- Numerical

Unit -II: Thermodynamic aspect of solution

12 hrs

(2) Partial Molar Properties

- Introduction, Definition of partial molar property
- Concept of chemical potential
- Gibbs-Duhem equation
- Effect of temperature on chemical potential
- Effect of pressure on chemical potential
- Determination of partial molar properties by intercept method
- Application of chemical potential
 - Henry's law
 - Raoult's law
 - Nernst distribution law

(3) Free energy and chemical equilibrium

- Introduction

- Free energy and work function
- Gibbs-Helmholtz equation
- Clausius-Clapeyron equation & its Application
- Van't Hoff isotherm & Van't Hoff isochore
- Applications & Numerical

Unit -III: Electrochemistry

12 hrs

(4) Fundamentals of Electrochemistry

- Introduction
- Types of concentration cell:
 - Electrode concentration cell
 - Electrolyte concentration cell
- Determination of potential of both types of cell
- Types of electrolyte concentration cell
 - With transference
 - Without transference
- Determination of potential of electrolyte concentration cell with transference
- Determination of potential of electrolyte concentration cell without transference
- Liquid junction potential:
 - Definition, Example, Elimination
- Application of EMF
 - Determination of solubility and solubility product of sparingly soluble salt with EMF
 - Determination of valency of metal ion
 - Determination of transport number of ion
 - Determination of dissociation constant of weak acid
 - Determination of degree of hydrolysis and hydrolysis constant
 - Determination of pH by EMF method with the help of H₂ electrode
- Numericals

Unit -IV: Electrometry

(5) Potentiometry and pH metry

12 hrs

- **Potentiometry**
- Introduction and interpretation of pH metry and Potentiometry.
- Importance of indicator and reference electrode in the measurement of EMF and pH
- E.M.F. method:
 - Study of acid – base titration
 - Redox titration
 - Argentometric titration including mixture of Cl⁻, Br⁻, I⁻ with graph and proper explanation.

- **pH metry**
- Definition, instrumentation & calibration
- Interpretation of various methods of determining pH value like pH paper method (Demonstration only), potentiometric method using only hydrogen electrode as indicator electrode and calomel electrode as reference electrode to determine pH value.
- Weak acid-strong base titration with curve and determination of dissociation constant (K_a) of weak acid.

Unit -V:

14 hrs

(6) Photochemistry

- Photochemical reaction, Photo sensitization, Fluorescence, Phosphorescence, Chemiluminescence
- Difference between photochemical and Thermochemical reaction
- Laws of Photochemistry: Grotius's-Draper law; Stark Einstein's law (i.e. law of photochemical equivalence)
- Quantum efficiency and Factors affecting quantum efficiency
- Reasons for low and high quantum yield (photochemical process)

(7) Phase rule

- Introduction
- Definitions of phase, components, degree of freedom
- General phase diagram
- One component system : Water system, Sulphur system
- Two component system : Zn-Mg system, Pb-Ag system
- Zeotropic&Azeotropic mixtures & separation by distillation

Text Books:

1. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2010,5th edition) *Essential of Physical Chemistry. New Delhi : S. Chand* (ISBN:81-219-2978-4) (Unit-1to 5)

Reference Books:

1. Negi, A. S.; Anand, S. C. (2007,2nd edition) *A Textbook of Physical Chemistry.* New Delhi: New age International Publisher (ISBN: 81-224-2005-0).
2. Atkins, P. W., De Paula, J., & Keeler, J. (2018,11th edition). *Atkins' physical chemistry.* Oxford university press. (ISBN: 978-0198814740).
3. ArunBahl; B.S. Bahl (2009,1st edition) *Numerical Problems in Physical Chemistry.* New Delhi: S. Chand (ISBN: 81-219-3084-7).
4. Madan, R. L. (2011, 3rd edition) *Chemistry for degree student First year.* New Delhi: S. Chand (ISBN: 978-8121932301).

Semester – IV		
Course Code	Course Title	Course Credit and hrs
19UCHCC403	Core-10: Agrochemicals	2 Credits - 2 hrs / wk

Objectives:

To enable the students to

- Understand the properties, manufacturing & applications of fertilizers, pesticides, fungicides, insecticides, weedicides & herbicides.
- Describe about Plant growth regulators.

Course Content

Hours

Unit-I: Fertilizers

09 hrs

- Plant nutrients: Definition, Classification and role in plant
- Definition, Classification, properties and importance of fertilizers
- Manufacturing & applications of following type of fertilizers
- Synthetic:
 - Nitrogenous Fertilizer: Ammonium nitrate, Ammonium sulphate, Urea, Calcium Cyanamide, DAP.
 - Phosphate fertilizer: Normal super phosphate, triple super phosphate, ammonium phosphate.
 - NPK fertilizer
- Natural:
 - Concept of organic fertilizer & vermicompost

Unit-II: Pesticide & Fungicide

05 hrs

- Definition, classification, chemistry, synthesis and application of the following:
 - Pyrethroids: Tetramethrin
 - Fungicides - Sulphur and Copper fungicides, Carboxin

Unit-III: Insecticides

05 hrs

- Definition, classification, applications and synthesis of the following
 - Organophosphate: Chlorpyrifos, Parathion, Malathion, Dimethoate
 - Organochlorides: DDT, BHC, Aldrin, Dieldrin, chlorobenzilate
 - Carbamates: Carbaryl, Fenobucarb, Aldicarb

Unit-IV: Weedicide & Herbicide

05 hrs

- Definition, classification, applications and synthesis of the following:
 - Trifluralin & Butachlor
 - Dimethoate & Isoproturon
 - MCPA & 2,4-D
 - Pendimethalin
 - Glyphosate

- Paraquat
- Dicamba
- Clopyralid

Unit-V: Plant growth regulators

06 hrs

- Definition, classification, application, synthesis and role in plant growth of the following:
 - Auxin
 - Gibberellic acid,
 - Cytokinin,
 - Ethylene,
 - Abscisic acid

Text book:

1. Sharma, B. K. (2014). *Industrial chemistry*. Krishna Prakashan Media (ISBN:978-8182838291). (Unit-1)
2. Thomas A. Unger, (1996...edition) *Pesticide Synthesis Handbook ProchromIndustriasQuimicas S/A Elsevier*, (ISBN: 9780815518532). (Unit-2)
3. U.S. Shree Ramulu,(1995, 2nd edition) *Chemistry of Insecticides and Fungicides: Oxford & IBH Pub* (Unit-3&4)
4. Jeremy A. Roberts (1988,1st edition) *Plant Growth Regulators*(ISBN:9781461575948) (Unit-5)

Reference Books:

1. Baker, D. R., Fenyes, J. G., Lahm, G. P., Selby, T. P., & Stevenson, T. M. (2002). *Synthesis of Agrochemicals and Agricultural Biotechnology in Modern Agriculture*. (ISBN:978-0841237834).
2. J. Benton Jones, Jr. (2012,1st edition). "Inorganic Chemical Fertilizers and Their Properties" in *Plant Nutrition and Soil Fertility Manual*, Second Edition. CRC Press, (ISBN 978-1-4398-1609-7).
3. Jones J. r, J. B., Wolf, B., & Mills, H. A. (1991, 1st edition). *Plant analysis handbook. A practical sampling, preparation, analysis, and interpretation guide*. Micro-Macro Publishing, Inc.(ISBN: 9781878148001)

Semester - IV		
Course Code	Course Title	Course Credit and hrs
19UCHCC404	Core Practical –8: Organic Chemistry Practical	2 Credits - 6 hrs / wk

Objectives:

To enable the students to

- Separate and identify unknown organic compound.
- Develop skill to prepare and purify different organic compound.

Laboratory experiments:

➤ Synthesis of different organic compounds:(10)

- Acetylation of Salicylic acid
- Benzoylation of aniline
- Preparation of iodoform from acetone
- Nitration of
 - Benzene
 - Acetanilide
- Bromination of
 - Acetanilide
 - Aniline
- Diazotization of sulphanilic acid
- Oxidation of Benzaldehyde
- Reduction of m-dinitro benzene

➤ Organic binary mixture separation (Solid-Solid & Solid-Liquid) (08)

- Acid-Phenol, Acid-Base, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral

➤ Organic qualitative analysis of Bi-functional compounds (Minimum-10)

Text books

1. Vogel, A. I., Furniss, B. S., Hannaford, A. J., Smith, P. W., & Tatchell, A. R. (1989, 5th edition). *Vogel's textbook of practical organic chemistry* (Vol. 5). New York: Longman Scientific & Technical. (ISBN: 978-8177589573)

Reference Books:

1. Hassner, A. (2012, 3rd edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).

Semester - IV		
Course Code	Course Title	Course Credit and hrs
19UCHCC405	Core practical - 9: Physical Chemistry Practical	2 Credits - 6 hrs / wk

Objectives:

To enable the students to

- Understand concept of EMF, types of cell and EMF series.
- Understand the potentiometric and pH metric titration.
- Develop skill to standardize instruments.

Laboratory experiments:

➤ pH metry(04)

- To determine normality and gms/lit. of xNHCl by pH metry.
- To determine normality and dissociation constant of weak acid ($\text{xN CH}_3\text{COOH}$) by pH metry.
- To determine normality and dissociation constant of dibasic acid (xN oxalic acid/malonic acid/maleic acid) using 0.5N NaOH solution.
- To determine amount of Aspirin in given tablet using 0.1N NaOH

➤ Potentiometry(05)

- To determine normality of Benzoic acid used 0.5N NaOH.
- To determine normality of given acid xNHCl using 0.5N NaOH solution.
- To determine normality of given acid xN Oxalic acid using 0.5N NaOH solution.
- To determine concentration of xN FAS using $\text{K}_2\text{Cr}_2\text{O}_7$.
- To determine normality and dissociation constant of given acid $\text{xN CH}_3\text{COOH}$ using 0.5N NaOH solution.

➤ Partition Coefficient(03)

- To study the distribution of Benzoic Acid between Toluene/Water
- To study the distribution of Benzoic Acid between Benzene/Water
- To determine distribution coefficient of Iodine between Carbon tetrachloride and water at given temperature.

➤ Thermodynamics (03)

- To determine heat of vaporization of given liquid (Benzene).
- To determine heat of vaporization of given liquid (Toluene)
- To determine heat of vaporization of given liquid (Chloroform)

➤ Phase Rule (03)

- To construct the phase diagram of two component system forming

compound with congruent melting point.

- To construct the phase diagram of two component system forming compound with incongruent melting point.
- To study the phase diagram of the ternary system acetic acid –water-chloroform.

➤ **Electroplating (04)**

- To electroplate copper on given object.
- To determine the amount of copper into given electrolyte.
- To electroplate nickel on given object.
- To determine the amount of nickel in to given electrolyte.

➤ **Partial Molar Volume (Advanced) (02)**

- To determine partial molar volume & excess volume of binary mixture.
- To determine partial molar volume & the composition of unknown mixture.

➤ **Fractional Distillation (01)**

➤ **Steam distillation (01)**

Reference Books:

1. Brian S. Furniss (1989,5thedition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Hassner, A. (2012,3rd edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
3. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989, 5th edition) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
4. Jerry R. Mohrig (2010,3rd edition) *Techniques in Organic chemistry*. London: W. H. Freeman & Company (ISBN: 1-4292-1956-4).
5. Svehla, G. (1979,5thedition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHCC501	Core 11: Spectroscopy & Separation Techniques-I	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Understand analytical strength of UV and IR spectroscopy
- Determine the symmetry of the molecules and its geometry with broad aspects
- Understand the importance and perfection of the chromatographic separation techniques for the organic and inorganic analysis

Course Content

Hours

Unit-1: UV-Visible Spectrometry

12 hrs

- Introduction
- Theory of ultra violet spectra
- Instrumentation
- Type of transition in organic molecules and order of energy;
- Explanation of auxochrome&chromophore
- Different shifts observed
- Effect of solvent, Franck-Condon principles
- Application of UV spectra
- Calculation of λ -max (1) Dienes and conjugated dienes (2) enones and dienones, i.e., unsaturated carbonyl compounds, (3) aromatic carbonyl system

Unit-2: IR Spectroscopy

12 hrs

- Introduction
- Range of IR & theory of IR
- Modes of fundamental vibrations
- IR active, force constant
- Vibration coupling
- Over tones & Fermi resonance
- Hot bands
- Finger print region
- Instrumentation
- Application of IR
- Structure of organic molecules from IR data [Problems]

Unit-3:Molecular Symmetry

10 hrs

- Introduction,
- Symmetry elements and symmetry operation with illustration
- Definition of Properties of group, subgroup and classes

- Products of symmetry operations
- Symmetry Point group: C₁, C_s, C_i, C_n, C_{nv}, C_{nh}, D_n, D_{nh}, D_{nd}, C_{∞v}, D_{∞h}, T_d, O_h, I_h
- Multiplication Table for: C_{nv}, D_{2h}, C_{2h}

Unit-4: Planner Chromatography

12 hrs

- Introduction
- Classification of chromatography - types of chromatography
- Some basic terminology related to chromatography: Adsorption chromatography, Partition Chromatography, Development, Developers, Elution, Eluents, Eluate, R_fvalue and R_x value

Paper chromatography:

- Principle of paper chromatography
- Properties of paper
- Experimental methods like: Ascending containing one dimensional and two dimensional method; and Descending method; circular method, Role of Spraying reagent e.g. Ninhydrine
- Representative applications of paper chromatography.

TLC:

- Introduction
- Principle
- Method of preparation & development of chromato-plate
- Visualization methods
- Applications of TLC

Unit-5: Column Chromatography

14 hrs

- Principle
- Apparatus
- Experimental techniques
- Visualization methods
- Absorbent selection and Solvent selection
- Representative applications of column chromatography.

Text book:

1. Sharma, Y. R. (2007,4th edition). *Elementary organic spectroscopy*. Delhi: S. Chand Publishing (ISBN:9788121928847).(Unit-1,2&3)
2. Gurdeep, R., Chatwal, S., &Anand, K. (2016,7th edition). *Instrumental methods of chemical analysis*. Himalaya publishing house (ISBN: 978-9350512067). (Unit-4&5)

Reference Books:

1. Dewan, S. K. (2019, 1st edition). *Organic spectroscopy*. (ISBN: 9788123919065)

2. Ahluwalia, V. K., & Goyal, M. (2000, 1st edition). *A textbook of organic chemistry*. Alpha Science Int'l Ltd.(ISBN:978-8173191596).
3. Spectroscopy of Organic Compounds by P. S. Kalsi (1998, 3rd edition); New Age International Publishers (ISBN:9788122411331).
4. Braithwaite, A., & Smith, J. F. (2012, 5th edition). *Chromatographic methods*. Springer Science & Business Media (ISBN: 978-0751401585).

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHCC502	Core 12: Polymer Chemistry	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Differentiate amongst various polymer, rubber, Adhesive, Laminates and Composites
- Synthesize, Analyses and characterize polymers

Course Content

Hours

Unit-I: Introduction to Polymers and Classification

10 hrs

- Introduction
- Classification of Polymers
- Classification based on origin of source
- Classification based on mode of polymerisation
- Classification of polymers based on intermolecular interaction (molecular forces)
- Classification of polymers based on structure
- Type of polymerization reaction

Unit-II Polymerization, Reaction Mechanism & Polymer Synthesis

12 hrs

- Addition (chain growth) polymerization
- Free radical polymerization
- Ionic polymerization
- Ziegler- Natta polymerization
- Stereochemistry of polymer plastic
- Types of plastics, thermo plastic. thermosetting plastic
- Synthesis of bakelite, teflon, melamine, phenol formaldehyde, polychloroprene.

Unit-III Rubbers, Adhesive and Composites

14 hrs

- Introduction to elastomeric material
- General properties and classification of elastomers
- Natural rubber (NR)
- Advantages, disadvantages and application of natural rubber (NR)
- Synthetic rubber: structure, advantages and disadvantages of: Isoprene rubber, butadiene rubber, styrene-butadiene rubber, butyl rubbers, nitrile-butadiene rubber.
- Adhesive: classification of adhesive, manufacturing, types of adhesive: protein adhesive, starch adhesive, cellulose adhesive.
- Polymer composites: FRC – importance and properties, manufacturing of composites, Aramid fiber material, Kevlar.

Unit-IV Polymer Testing and characterization

12 hrs

- **Tests for mechanical properties of polymer:** Tensile strength, elasticity, plasticity, fatigue, compressibility, tenacity, impact resistance, wear Resistance, Flexural Strength, Flexural Modulus, Failure Load, and Compressive Strength.
- **Tests for physical properties:** Polymer weight, average molecular weight, number average molecular weight, Equipment for testing of polymer.

Unit-V Kinetics of polymerization and Nano-Chemistry

12hrs

- **Kinetics study of polymerization reaction**
kinetics study of cationic polymerisation ,anionic polymerisation and free radical polymerisation
- **Nano-Chemistry**
Introduction and definitions involved in nano chemistry, Difference between nano and bulk nanomaterials, Classification of nano-materials, Properties of nano-materials, Synthesis of nano-materials, Applications of nano-materials.

Text book:

1. Sharma, B. K. (2014). *Industrial chemistry*. Krishna Prakashan Media., (ISBN: 978-8182838291). (Unit-1to 4)
2. Gowariker, V., Viswanathan N. V., Sreedhar, J., (2005), *Polymer Science*, Reprint: New Delhi: New Age International Pvt. Ltd. (ISBN: 085226-3074). (Unit-1to5)

Reference Books:

1. Crawford, R. J., & Martin, P. J. (2020, 4th edition). *Plastics engineering*. Butterworth-Heinemann. Elsevier, (ISBN:978-0081007099).
2. McGraevy C, (1994, 1st edition). *Polymer Reactor Engineering*, Chapman & Hall. (ISBN: 978-9401045834)
3. Brydson, J. A. (1999, 7th edition). *Plastics materials*. Elsevier: Butter worth-Hienemann. (ISBN: 0750641320)
4. Bréchnignac, C., Houdy, P., & Lahmani, M. (Eds.). (2008). *Nanomaterials and nanochemistry*. Springer Science & Business Media. (ISBN: 978-9814277921)
5. Pradeep, T. (2007). *Nano: the essentials*. Tata McGraw-Hill Education. (ISBN:9780070617889)

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHCC503	Core 13: Industrial Formulations (Self-Study core course)	4 Credits - 2 hrs./Wk

Objectives:

To enable the students to

- Understand entrepreneurship
- Understand the miracles of the chemical formulations for the different products
- Understand the chemistry involved in the compounds of the daily life

Hours

Course Content

Unit-I: Soap and Detergents

12 hrs

- Introduction to soap
- Raw materials for manufacturing of soap
- Methods for manufacturing of soap
 - (a) Batch process
 - (b) Continuous process
- Types of soap: toilet soap, transparent soap, shaving soap, neem soap,
Liquid soap
- Recovery of glycerin from spent lye.
- Introduction to detergents
- Principal group of synthetic detergents
- Bio degradability of surfactants
- Classification of surface active agents
- Anionic detergents
- Manufacturing of anionic detergents
 - (a) Oxo process
 - (b) Alfol process
 - (c) Welsh process
- Cationic detergents
- Manufacturing of non – ionic detergents
- Manufacturing by batch process
- Amphoteric detergents
- Manufacture of shampoo

Unit-II: Paints and Primers

12 hrs

- Introduction
- Classification of paints
- Constituents of paints
- Manufacture of paints
- What are the requirements for a good paint
- Paints failure

- Emulsion paints, constituents of emulsion paints

Unit-III: Ceramics and Refractories

12 hrs

- Introduction to ceramics
- Raw materials
- Classification based on reduction in porosity
- Manufacturing of ceramics
- Body preparation using clay slip
- Introduction to refractories
- Classification of refractories
- Properties of refractories
- Manufacturing of refractories
- Fire clay bricks manufacturing, properties and uses

Unit-IV: Cement

12 hrs

- Introduction
- Types of cement
- Raw material for manufacturing
- Cement rock beneficiation
- Manufacturing processes: (a) Dry process (b) Wet process
- Setting of cement: (a) Hydrolysis (b) Hydration
- Properties of cement
- Testing of cement
- Indian standard institute (ISI) specification of cement
- Uses of cement

Unit-V: Glass

12 hrs

- Introduction
- Physical and chemical properties of glass
- Raw materials for manufacture
- Chemical reactions involved
- Method of manufacturing: Formation of batch material, melting, shaping, annealing, finishing

Text book:

1. Sharma, B. K. (2014) *Industrial chemistry*, Goel publishing house, (ISBN; 9788187224006). (Unit-1to5)

Reference Books:

1. Flick, E. W. (2013, 1st edition). *Advanced cleaning product formulations* (Vol. 2). Elsevier.(ISBN: 9780815516064)
2. Hannan, H. J. (2007). *Technician's Formulation Handbook for Industrial and Household Cleaning Products*. Lulu. com.(ISBN: 978-0615156019).
3. Flick, E. W. (2014,1st edition). *Cosmetic and toiletry formulations* (Vol. 3). Elsevier (ISBN: 9780815516712).

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHDC501	DSE-Core-1: Green Methods in Chemistry	3 Credits - 3hrs / wk

Objectives:

To enable the students to

- Understands principles of Green Chemistry.
- Create awareness among students and teachers about green Chemistry for the safe future.
- Use eco-friendly approaches in synthesizing chemicals.

Course Content

Hours

Unit-I: Green Chemistry

10 Hrs

- Principles of green chemistry and its applications
- Green reactions like:
 - Streckersynthesis
 - Reformatskyreaction
 - Diels -Alder reaction
 - Grignard reaction.

Unit-II: Microwave assisted organic synthesis

10 Hrs

- Introduction
- Principle and instrumentation
- Choice of solvent
- Microwave assisted synthesis of:
 - Knoevenagelcondensation
 - Biginellireaction
 - Aldol condensation

Unit-III: Reaction of ionic liquids and Green solvents

10 Hrs

- Introduction of ionic liquid
- Application of ionic liquid in the following reactions:
 - Diels-alder reaction
 - Knoevenagel condensation
 - Friedel crafts alkylation
- Introduction of green solvents
- Types of green solvents
- Industrial green solvents
- Application of green solvents in separation process
- Green solvents in organic synthesis

Unit-IV: Green catalyst

07 Hrs

- Introduction of catalyst
- Concept in acidity and solid acid catalyst
- Industrial application of acid catalyst, photo catalysis and bio-catalysis
- Recent advances in phase transfer catalysis

Unit-V: Future Trends in Green Chemistry

08 Hrs

- Oxidation reagents
- Multifunctional reagents
- Combinatorial green chemistry
- Proliferation of solvent less reactions
- Green chemistry in sustainable development

Text book:

1. Ahluwalia, V. K. (2013, 1st edition). *Green Chemistry: A Textbook*. Alpha Science International. (ISBN: 978-1842657539)
2. De, A. K. (2015, 7th edition) *Environmental Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2617-5). (Unit-4)
3. American Chemical Society, Ryan, M. A., & Tinnesand, M. (2002). *Introduction to green chemistry: Instructional activities for introductory chemistry*. American Chemical Society.

Reference Books:

1. Douglas A. Skoog, West, Holler, Crouch (2004, 8th edition) *Fundamental of Analytical Chemistry*. Mexico: Thomson-Brooks/Cole (ISBN: 81-315-0051-9).
2. Paul T. Anastas (2012, Volume 9: Designing Safer Chemicals) *Handbook of Green Chemistry: Green Processes*. Weinheim: Wiley-VCH Verlag & Co. (ISBN: 978-3-527-32639-6).
3. Fahey, J. T., & Maelia, L. E. (Eds.). (2016). *Green Chemistry Experiments in Undergraduate Laboratories*. Washington, DC : American Chemical Society, (ISBN: 9780841231764)
4. Henrie, S. A. (2015, 1st edition). *Green chemistry laboratory manual for general chemistry*. CRC Press. (ISBN: 9781482230208)
5. Lancaster, M. (2016). *Green chemistry 3rd edition: an introductory text*. Royal society of chemistry. (ISBN: 978-1-78262-294-9)

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHDC502	DSE-Core-1: Soil Analysis	3 Credits - 3hrs / wk

Objectives:

To enable the students to

- Classify various types of soil
- Estimate vital soil parameters
- Suggest soil for healthy crop

Course Content

Hours

Unit-I: Soil Analysis-Physical Test

07 hrs

- Soil Texture
- Water Holding Capacity
- Bulk Density
- Hydraulic Conductivity

Unit-II: Mineralogical Analysis

12 hrs

- **Water Content and Loss on Ignition:**
 - Introduction, principle, equipment and methods.
- **Particle Size Analysis:**
 - Introduction, principle, Law of Sedimentation, Particle Suspension and Dispersion, Density Method with Variable Depth.

Unit-III: Soil Analysis- Chemical Test

08 hrs

- pH,
- Electrical Conductivity (EC),
- Organic Carbon,
- Free Lime,
- Macronutrients- K, Ca, Mg
- Micronutrients- Cu, Fe, Zn, Mn etc.

Unit-IV: Organic Forms of Nitrogen, Mineralizable Nitrogen

11 hrs

- Introduction
- The Nitrogen Cycle
- Types of Methods
- Classical Methods:
 - Forms of Organic Nitrogen Released by Acid Hydrolysis,
 - Organic Forms of Nitrogen: Simplified Method, Urea Titration.
- Complementary Methods: Alternative Procedures for Acid Hydrolysis, Determination of Amino Acids, Determination of Amino Sugars.

Unit-V: Phosphorus analysis

07 hrs

- Introduction
- Total Soil Phosphorus
- Wet and dry Mineralization
- Fractionation of Different Forms of Phosphorus
- Sequential Methods
- Isotopic Dilution Methods
- Titration of P in the Extracts
- Titration of Ortho-phosphoric P by Spectrocolorimetry

Text book:

1. Motsara, M. R., & Roy, R. N. (2008). *Guide to laboratory establishment for plant nutrient analysis* (Vol. 19). Rome: Food and Agriculture Organization of the United Nations. (ISBN: 978-92-5-105981-4)

Reference Books:

1. Marc Pansu, Jacques Gautheyrou (2003). *Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods*. New York: Springer Berlin Heidelberg (ISBN: 3-540-31210-2)

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHCC504	Core Practical-11: Spectroscopy & Separation Techniques – 1 Practical	2 Credits - 6 hrs./Wk

Objectives:

To enable the students to

- Understand chromatography techniques.
- Suggest chromatographic techniques for effective separation
- Read the chromatogram from the R_f value and match the components with the standards available

Laboratory experiments

➤ Chromatography (08)

1. To determine R_f value of individual and mixture of amino acid by ascending paper chromatography.(2)
(Histidine, Alanine, Phenylalanine, Prolamine, Methionine, Lysine, Glutamic acid, Tyrosine and Argeine)
2. To determine R_f value of individual and mixture of amino acid by circular paper chromatography.(2)
(Histidine, Alanine, Phenylalanine, Polyamine, Methionine, Lysine, Glutamic acid, Tyrosine and Argeine)
3. To determine R_f value of individual and mixture of metal ions by ascending paper chromatography. (2)
($NiCl_2$, $CoCl_2$, $CuCl_2$, $FeCl_3$, $NiCl_2 \cdot CoCl_2$)($FeCl_3CuCl_2, CoCl_2$)
4. To determine R_f value of individual and mixture of metal ions by circular paper chromatography.(2)
($NiCl_2$, $CoCl_2$ $CuCl_2$, $FeCl_3$, $NiCl_2 \cdot CoCl_2$, $FeCl_3CuCl_2, CoCl_2$)
5. To determine R_f value of individual and mixture of various sugar sample by paper chromatography.(1)
6. To determine R_f value of individual and mixture of various metal ion by thin layer chromatography.(1)
7. Preparation of TLC plate .(1)
8. Demonstration of Column Preparation(1)

➤ Inorganic Qualitative analysis (Six radicals) (12)

➤ UV-Spectroscopy (λ_{max}) (02)

Laboratory Manual/ Book

1. Ahluwalia, V. K., &Dhingra, S. (2005). *College practical chemistry*. Universities Press. Hyderabad:Universities Press (India) Pvt. Ltd,
2. Pandey, O. P., Giri, S., &Bajpai, D. N. (1972). *Practical Chemistry: For B. Sc. I, II & III Year Students*. S. Chand., New Delhi: S. Chand Publication.(ISBN: 9788121908122)
3. Chemistry Practical (B.Sc. Semester-VI), D.M. Purohit, R. V. Zala, EktaPrakashan.

Reference Books:

1. Smith R.M.(2004) *Separation Techniques in Analytical Chemistry*; Wiley-Blackwell (ISBN: 978-0471493884)
2. Gifford, L. A. (1976) *Separation methods in chemical analysis*, Chichester: Wiley, New York (ISBN 0-471-60490-9).

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHCC505	Core Practical –12: Polymer Chemistry Practical	1 Credits - 3 hrs./Wk

Objectives:

To enable the students to

- Synthesize polymers.
- Identify polymers qualitatively.

Laboratory experiments:

➤ Preparation of some Industrial polymer compound (12)

1. To prepare primary cellulose acetate from cellulose.
2. To prepare Urea formaldehyde resin from urea.
3. To prepare phenol formaldehyde resin from phenol.
4. To prepare glyptal resin.
5. To prepare polystyrene by solution polymerization technique.
6. To prepare polystyrene by suspension polymerization technique.
7. To prepare polystyrene by bulk polymerization technique.
8. To prepare Melamine formaldehyde from melamine.
9. To prepare Dacron (Terylene) polymer.
10. To prepare polystyrene from styrene.
11. To prepare polymethacrylate (PMMA) by bulk polymerisation.
12. To prepare polysulphide rubber (Thiokol).

➤ Identification and qualitative analysis of unknown polymer (06)

Laboratory Manual/ Book:

1. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (1986). *Polymer science*. New Age International (ISBN: 9788122438130)
2. Crompton, T. R. (1998). Preliminary Qualitative Identification of *Polymers*. In *Manual of Plastics Analysis (pp. 131-162)*. Boston: Springer (ISBN: 978-1-4899-1403-3)

Reference Books

1. Shah, V. (2007, 3rd edition). *Handbook of plastics testing and failure analysis* (Vol. 21). John Wiley & Sons. (ISBN: 978-0-471-67189-3)
2. Bolgar, M., Hubball, J., Groeger, J., & Meronek, S. (2015). *Handbook for the chemical analysis of plastic and polymer additives*. CRC Press. (ISBN: 9780367267896)

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHDC503	DSE Core Practical-1: Green Methods in Chemistry Practical	1 Credits - 3 hrs./Wk

Objectives:

To enable the students to

- Understand the difference in green and non-green methods.
- Prepare the green methods for safe future.

Laboratory experiments:

- **Synthesis of Some organic compound(06)**
 - Acetylation of Primary Amine
 - Nitration of salicylic acid by green method.
 - Bromination of acetanilide by green method.
 - Preparation of 1,1-bis-2-naphthol by radical coupling method.
 - Synthesis of bio-diesel from vegetable oil.
 - Synthesis of dihydropyrimidone by green method.
- **Synthesis of Schiff 's base (Substituted aromatic aldehydes and amines)(03)**
- **Synthesis of chalcone (Substituted aromatic aldehydes and acetophenones)(03)**

Laboratory Manual/ Book:

1. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST.
2. Fahey, J. T., &Maelia, L. E. (Eds.). (2016). *Green Chemistry Experiments in Undergraduate Laboratories*. American Chemical Society (ISBN: 9780841231764)

Reference Books

1. Henrie, S. A. (2015, 1st edition). *Green chemistry laboratory manual for general chemistry*. CRC Press. (ISBN: 9781482230208)

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHDC504	DSE Core Practical-1: Soil Analysis Practical	1 Credits - 3 hrs./Wk

Objectives:

To enable the students to

- Classify various types of soils.
- Analyse the nutrients of the soil.
- Suggest soil fertility and crop.

Laboratory experiments:

1. pH Measurement of Soil
2. Conductivity measurement of soil
3. Water holding capacity of soil
4. Organic Carbon measurement of Soil (Van Bemelen formula)
5. Particle size analysis of soil
6. Determination of Available (Mineralization) Nitrogen in Soil
7. Determination of minerals in Soils and Plants by Atomic Absorption Spectrophotometer (Demonstrative experiment)
8. Determination of Total Nitrogen in Soil /Plant/Water
9. Determination of Phosphorous in Soil /Plant/Water
10. Determination of Potassium in Soil /Plant/Water
11. Determination of Sulphur in Soil /Plant/Water
12. Estimation of Boron in Soil /Plant/Water

Laboratory Manual/ Book:

1. Thakur R.K, Baghel S.S., Sharma G.D., Sahu R.K., Amul P.C., *Laboratory Manual on Biotic and Abiotic Resources Management for Eco-friendly and Sustainable Agriculture*
(<http://jnkvv.org/PDF/SoilScience/Lab%20Manual/LabManual2011.pdf>)

Reference Books:

1. Jones Jr, J. B. (Ed.). (1999, 1st edition). *Soil analysis handbook of reference methods*. CRC Press (ISBN: 9780849302053).
2. Peverill, K. I., Sparrow, L. A., & Reuter, D. J. (Eds.). (1999). *Soil analysis: an interpretation manual*. CSIRO publishing (ISBN: 0-643-06376 5)
3. Drees, L. R., & Ulery, A. L. (2008). *Methods of Soil Analysis. Part 5, Mineralogical Methods*. Soil Science Society of America (ISBN: 978-0891188469)

Semester – V		
Course Code	Course Title	Course Credit and hrs
19UCHCC506	Core 14:Computer Based Test	1 Credits

Objectives:

To enable the students to

- Revise previous semester syllabus.
- Prepare for competitive exams.
- Face screening test in various chemical companies.

Course Content

- Computer Based test based on syllabus from SEM-I to V core courses.

Semester – V		
Course Code	Course Title	Course Credit and hrs
	Group Project /Industrial Training / Instrumental Training	3 hrs / wk

Objectives:

To enable the students to

- Improve practical skill of various industries.
- Develop skill for project writing.
- Operate and aware of various instruments.

Course Content

- The Group Project/ Industrial Training/ Instrumental Training will be offered to undergraduate students in V and VI semester. For semester-V, total 3 hrs and for semester-VI total 4 hrs will be allotted.

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHCC601	Core-15: Spectroscopy & Separation Techniques – II	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Understand the powerful spectroscopic techniques
- Read the spectral data for molecular structures
- Apply the modern analytical hyphenated techniques

Course Content

Hours

Unit-1: NMR Spectroscopy

14 hrs

- Introduction
- Principle
- Nuclear quantum number
- Equivalent and non-equivalent protons with illustrations: enantiomeric and diastereomeric protons, shielding and deshielding of protons
- Chemical shift
- Relative intensity of signals
- Spin-spin coupling and coupling constant
- Application of NMR
- Problems for determination of structure of organic molecules

Unit-2: Mass Spectroscopy

10 hrs

- Introduction
- Basic principle and Theory of mass spectroscopy
- Instrumentation
- Mass Spectrum
- Determination of Molecular Weight
- Mc-Lafferty Rearrangement
- Nitrogen Rule
- Metastable ion
- General fragmentation modes
- Important features for the mass spectra of alkanes

Unit-3: Problems based on UV, IR, NMR & Mass spectroscopy

14 hrs

- Structural elucidation of small organic molecules based on combination of UV, IR, NMR, and MASS data - minimum 14 examples.

Unit-4: Ion-Exchange chromatography

08 hrs

- Introduction
- Principle & Theory
- Type of Ion Exchange Chromatography & resins
- Properties of ion exchange resins
- Applications of ion exchange chromatography

Unit-5: GLC, GSC, HPLC and hyphenated technique GC-MS, LC-MS

14 hrs

Gas chromatography

- Introduction & principle
- Types of Gas Chromatography: GLC and GSC
- Instrumentation, Evaluation selection and characteristic of carrier gas, Effect of temperature & pressure of gas, applications.

HPLC

- Principle, Working theory, Instrument- Flow diagram and main components, Applications.

Hyphenated Technique

- GC -MS: Principle & theory, Applications
- LC -MS: Principle & theory, Applications

Text books:

1. Sharma, Y. R. (2007). *Elementary organic spectroscopy*. New Delhi: S. Chand Publishing (ISBN: 9788121928847) (Unit-1,2 & 3)
2. Chatwal, G. R., & Anand, S. K. (2019). *Instrumental Methods of Chemical Analysis: (for Hons. and Post-graduate Students of Indian and Foreign Universities)*. Himalaya publishing house. (ISBN: 978-93-5142-088-0)(Unit-4&5)

Reference Books:

1. Dewan, S. K. (2019, 1st edition). *Organic spectroscopy*. (ISBN: 9788123919065)
2. Sharma, B. K. (2014). *Industrial chemistry*. Krishna Prakashan Media (ISBN:978-8182838291).
3. Kalsi, P. S. (2007). *Spectroscopy of organic compounds*. New Age International (ISBN: 9788122415438)
4. Fowles, I. A. (1995, 2nd edition). *Gas chromatography: Analytical chemistry by open learning* (Vol. 1, No. 3). Chichester, New York: Wiley (ISBN: 978-0-471-95468-2)
5. Braithwaite, A., & Smith, F. J. (1999, 5th edition). *Chromatographic methods*, Netherlands: Springer (ISBN: 978-94-011-0599-6)

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHCC602	Core-16: Heterocyclic Chemistry and Synthetic Drugs	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Identify heterocycles present in synthetic drugs
- Synthesis heterocycles
- Synthesis different drugs

Course Content

Hours

Unit-1: Fundamental of Heterocyclic chemistry

08 hrs

- Introduction
- Classification and nomenclature
- Three member heterocycles:
 - Preparation and properties of
 - Aziridine
 - Oxirane
- Four member heterocycles:
 - Preparation and properties of
 - 1,2-diazetidene
 - 1,2-dioxetane

Unit-2: Five membered and fused five member heterocycles

11 hrs

- Introduction
- Five membered heterocycles:
 - Structure, synthesis. physical and chemical properties of:
 - Pyrrole
 - Furan
 - Thiophene
- Fused Five membered heterocycles:
 - Synthesis. physical and chemical properties of:
 - Indole
 - benzofuran

Unit-3: Six membered and fused six member heterocycles

14 hrs

- Introduction
- Six membered heterocycles:
 - Structure, synthesis. physical and chemical properties of:
 - Pyridine
 - Pyridazine
 - Pyrimidine
 - Pyrazine

- Fused six membered heterocycles:
 - Structure, synthesis. physical and chemical properties of:
 - Quinoline
 - Isoquinoline
 - Quinazoline

Unit-4: Synthetic drugs: Anaesthetics & Analgesics

13 hrs

- Introduction
- Structure, use, dose, dosage form, structure activity relationship and synthesis of:
 - Local and General Anaesthetics:
 - Benzocaine
 - Lignocaine
 - Ketamine
 - Antipyretic - Analgesics:
 - Paracetamol
 - Phenyl butazone
 - Anti inflammatory:
 - Ibuprofen

Unit-5: Drugs action on Infectious Disease

14 hrs

- Introduction, Structure, use, structure activity relationship and synthesis of:
 - Anti-malarial:
 - Chloroquine
 - Pyrimethamine
 - Antibiotics:
 - Penicillin-V
 - Amoxicillin
 - Antiviral Drugs:
 - Acyclovir
 - Amantadine

Text book:

1. Bansal, R. K. (2009, 5th edition). *Laboratory manual of organic chemistry*. Delhi: New Age International (ISBN: 9788122424744)(Unit-1,2 & 3)
2. V. Alagarsamy (2013, 2nd edition). *Textbook of medicinal chemistry*. Elsevier India (ISBN: 978-8131233221)(Unit-4&5)
3. Strømgaard, K., Krogsgaard-Larsen, P., & Madsen, U. (Eds.). (2017). *Textbook of drug design and discovery*, CRC press (ISBN: 9781498702782).
4. Reddy C.S.,(2012) *Textbook of Synthetic Drugs*. Cumpus Books International(ISBN: 9788180303692)(Unit-4&5)

Reference Books:

1. Dr. BeenaNegi, Dr. Rakesh Kumar Parashar, Rajbir Singh. (2002) *Chemistry of Heterocyclic Compounds by Synthetic Drugs*, Mittal Publications (ISBN: 9789384726140)
2. May, P. (1911). *The chemistry of synthetic drugs*. Longmans, Green and Company.

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHCC603	Core 17: Chemistry of Natural Products	4 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Understand the different useful compounds present in plants.
- Isolate the useful compounds present in plants.
- Classify the biomolecules available in nature.

Course Content

Hours

Unit-1: Alkaloids

10 hrs

- Introduction
- Occurrence and Classification
- Isolation
- General method of proving structure of Alkaloids
- Constitution, Properties and Synthesis of:
 - Coniine
 - Nicotine
 - Papaverine

Unit-2: Terpenoids

10 hrs

- Introduction
- Occurrence and Isolation
- General characteristics of Terpenoids
- Isoprene Rule and modification
- Constitution and Synthesis of:
 - Citral
 - α -Terpineol
 - α -Pinene

Unit-3: Carbohydrates

15 hrs

- Introduction
- Classification and nomenclature
- General reactions of monosaccharides (with reference to Glucose and Fructose)
- Inter-conversions:
 - Conversion of Aldose to the corresponding Ketose
 - Conversion of Aldose to the next higher Ketose (Wolfform method)
 - Conversion of Aldose to the Ketose having two more

- carbon atoms (Sowden method)
 - Conversion of Ketose to the corresponding Aldose Step-up reactions (Ascending in Aldose series)
 - Kiliani Reaction
 - SwodenNitromethane reaction
 - Step-down reactions (Descending in Aldose series)
 - Aldohexose to Aldopentos: Ruff's Method
- Configuration of monosaccharides
- Ring structure of Aldoses
- Determination of ring size of Glucose by
 - Methylation method
 - Periodic oxidation method
- Mutarotation of D (+) glucose

Unit-4: Amino acids, Peptides and Protiens

15 hrs

- Introduction
- Name and formula of amino acids
- Classification of amino acids name and formula
- Synthesis of amino acids by:
 - Amination of α -halogen acids
 - Gabriel phthalimide synthesis
 - Hofmann Degradation
 - Erlen - Meyer Azlactone synthesis
 - Hydantoin method
- Physical & Chemical properties of amino acids
- Zwitter ion and isoelectric point
- Introduction to Polypeptides
- Synthesis of Polypeptides by:
 - Bergmann Method
 - Sneechn's Method (Use of Phthaloyl group)
 - Fischer's Method (use of p-toluenesulphonylchloride)
- Introduction and classification of proteins
- Constitution & Synthesis of thyroxin

Unit-5: Plant pigments

10 hrs

Anthocyanin

- Introduction
- General nature of the Anthocyanins
- Functions of Anthocyanins
- Extraction
- Determination of structure of the Anthocyanidins
- General methods of synthesizing the Anthocyanidins
- Synthesis of: Cyanin Chloride, Pelargonin Chloride

Flavonoids

- Introduction
- Classification (Flavone, Flavonol)
- Extraction of Flavonoids
- General properties of Flavonoids
- Basic Structures of the flavones and flavonols
- Synthesis of:
 - Flavone: Apiginine
 - Flavonol: Quercetin

Text book:

1. Bhat, S. V., Nagasampagi, B. A., & Sivakumar, M. (2013). *Chemistry of natural products*. Narosa Publishing House (ISBN: 978-8184873184)(Unit 1to3)
2. Jagdamba Singh, Syed Mashood Ali, Jaya Singh, (2018, 8thediton) *Natural Products*. Pragatiprakashan (ISBN: 9789387151666) (Unit-4&5)

Reference Books:

1. Thomson, R. H. (Ed.). (2012, 2nd edition) *The chemistry of natural products*. Springer Science & Business Media (ISBN: 978-94-010-4950-4)
2. Ayodhya Singh, (2004) *Chemistry of Natural Products: Alkaloids and Terpenoids*; Campus Books International (ISBN: 978-8180300653)
3. Miljkovic, M. (2009, 1st edition). *Carbohydrates: synthesis, mechanisms, and stereoelectronic effects*. Springer Science & Business Media (ISBN: 978-1-4614-9825-4)
4. Grotewold, E. (Ed.). (2006, 1st edition). *The science of flavonoids*. New York: Springer (ISBN: 978-0-387-28822-2)
5. Goodwin, T. W. (1976). *Chemistry and biochemistry of plant pigments*. New York: Academic Press.
6. Finar, I. L. (2002, 5thediton). *Organic Chemistry. Vol. 2. Stereochemistry and the Chemistry of Natural Products..* Longmans (ISBN: 9788177585421)

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHDC601	DSE Core-2: Unit Operations & Processes	3 Credits - 3hrs / wk

Objectives:

To enable the students to

- Understand the dynamics of fluid flow.
- Apply basic principles of heat transfer to industrial equipments.
- Study various unit processes in chemical industries
- Understand the process flow diagram and various process parameters

Course Content

Hours

Unit-1: Filtration and Centrifuge

09 hrs

Filtration

- Introduction
- Filter media and Filter aids
- Classification
- Construction, working, merits and demerits of following Equipment:
 - Bed Filter/Sand filter
 - Sparkler filter
 - Rotary drum filter
 - Nutch filter
 - Nutrex Filter
 - Bag filter
 - Plate and frame filter
 - Leaf filter

Centrifuge

- Introduction
- Types of centrifuges
- Tubular bowl
- Disc bowl

Unit-2: Drying

08 hrs

- Introduction
- Drying curve
- Factors affecting rate of drying
- Classification of dryers
- Construction, working, merits and demerits of following Equipment:
 - Tray dryer

- Rotary dryer
- Flash dryer
- Drum dryer
- Spray dryer

Unit-3: Sulphonation & Hydrogenation

10 hrs

Sulphonation:

- Introduction
- Sulfonating agents
- Chemical factors and Physical factors
- Outline of mechanism of Sulphonation process
- Sulphonation process of:
 - Benzene
 - Naphthalene
 - Dodecyl benzene

Hydrogenation:

- Introduction
- Various methods of reduction
- Chemical factors and Physical factors
- Outline of chemical kinetic mechanism and thermodynamics
- Various hydrogenating catalyst:
 - Hydrogenation process of vegetable oil
 - Synthesis process of methanol

Unit-4: Oxidation & Hydrolysis

08 hrs

Oxidation:

- Introduction
- Types of oxidation reaction
- Various oxidizing agents
- Chemical factors and Physical factors
- Manufacturing process, properties and uses of:
 - Acetic acid
 - Acetaldehyde
 - Benzoic acid
 - Phthalicanhydride
 - Maleic anhydride,

Hydrolysis:

- Introduction
- Hydrolysing agents
- Chemical factors and Physical factors
- Outline of chemical kinetic and mechanism
- Hydrolysis of starch

Unit-5: Alkylation & Esterification

10 hrs

Alkylation:

- Introduction
- Types of alkylation reaction
- Types of alkylating agents
- Chemical factors and Physical factors
- Manufacturing process, properties and uses of:
 - Alkyl aryl detergents
 - Ethyl benzene
 - Dimethyl aniline
 - Phenyl ethyl alcohol

Esterification:

- Introduction
- Types of esterification reaction
- Types of Esterification agents
- Chemical factors and Physical factors
- Manufacturing process, properties and uses of:
 - Cellulose acetate
 - Vinyl acetate
 - Ethyl acetate

Text book:

1. K. A. Gavhane, (2016, 1st edition), *Unit Operations-I*, Nirali Publications, (ISBN: 978-81-96396—11-4). (Unit-1 to 3)
2. Bansal, R. K. (2005). *A textbook of fluid mechanics*. Firewall Media (ISBN: 9788131802946)
3. Narayanan C.M. and Bhattacharya B.C. (2016,1st edition), “*Unit Operations and Unit Processes: Including Computer Programs*”, Volume 2, CBS: (ISBN: 9788123914879)(Unit-4&5)
4. Groggins P. H. (2007, 14th edition), *Unit Processes in Organic Synthesis*, Tata Mcgraw-Hill (ISBN: 978-0074621431)(Unit-4&5)

Reference Books:

1. Sukhatme, S. P. (2005). *A textbook on heat transfer*, Universities Press (IN) Pvt. Ltd. (ISBN: 81-7371-544-0).
1. Mohanty A. K., (2006), *Fluid Mechanics*, Prentice Hall of India Pvt. Ltd., (ISBN: 81-203-0894-8).
2. Desikan P. and Sivakumar T.C. (1982), “*Unit Processes in Organic Chemical Industries*”, IITM
3. Austin G. T., (1984, 5th edition), *Shreve’s Chemical Process Industries*, McGraw-Hill (ISBN: 978-0070661677)

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHDC602	DSE Core–2: Surface Coating Techniques	3 Credits - 3 hrs / wk

Objectives:

To enable the students to

- Apply the coating techniques
- Electroplate the surfaces effectively

Course Content

Hours

Unit-1: Surface Coating

06 hrs

- Introduction,
- Objectives and application of coating on metal and non - metal,
- Classification of surface coating (inorganic and organic),
- Preliminary treatment of surfaces.

Unit-2: Organic Surface Coating

12 hrs

- Chemistry, composition and characteristics
- Role and applications of oil paint
- Manufacturing and method of application on surface of oil paint
- Paint remover
- Manufacturing of water paint (emulsion paints), varnishes, lacquers and wax polishes

Unit-3: Inorganic Surface Coating – Electroplating

08 hrs

- Introduction of electroplating techniques of copper, zinc and chrome.
- Classification and theory of copper, zinc and chrome electroplating,
- Applications

Unit-4: Inorganic Surface Coating - Non - electric Coatings

09 hrs

- Theory, characteristics, special application and working techniques
- hot dipping, metal spraying, vacuum metalising, vitreous coating

Unit-5: Additive agents for Surface Coatings

10 hrs

- Introduction, classification and role of additives in surface coating processes
- Additives brightener, solvents, emulsifiers.

Text book:

1. Paul S. (1995, 2nd edition), *Surface Coatings: Science and Technology* Wiley. (ISBN: 978-0471958185) (Unit-1to5)

Reference Books:

1. Sharma, B. K. (2014) *Instrumental Method of Chemical Analysis*. Meerut: GOEL publishing House (ISBN: 978-81-8283-099-8).
2. Arthur A. Tracton; Abdel Salam Hamdymakhlouf. (2014,3rd edition), *Coatings Technology Handbook*, Elsevier Science & Technology (ISBN: 1420027328, 9781420027327).

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHCC604	Core Practical-16: Heterocyclic Chemistry and Synthetic Drugs Practical	2 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Synthesize drug intermediates and drugs molecules by different reaction steps.

Laboratory experiments:

- **Organic Qualitative analysis of binary mixture (12)**
- **Synthesis of Heterocycles like: (Any 6)**
 1. Phthalic anhydride
 2. Phthalamide
 3. Benzotriazole
 4. Benzimidazole
 5. Coumarin
 6. Dihydro pyrimidine
 7. Pyridine
 8. 3-methyl-1(2,4-dinitro)-phenyl-5-Pyrazolone
- **Synthesis of Drugs or intermediates like: (Any 6)**
 1. Aspirin (Acetylation of salicylic acid)
 2. Paracetamole from 4-aminophenol
 3. Pyrazole from EAA and Phenyl hydrazine
 4. PABA from p-nitrobenzoicacid
 5. Methyl salicylate
 6. Lidocaine
 7. Benzocaine

Laboratory Manual/ Book

1. Furniss, B. S. (1996, 5th edition). *Vogel's textbook of practical organic chemistry*. Pearson Education India. (ISBN: 978-0582462366).

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHCC605	Core Practical –17: Chemistry of Natural Products Practical	1 Credits - 2 hrs / wk

Objectives:

To enable the students to

- Extract the desired molecules from natural sources.

Laboratory experiments:

➤ Extraction of Natural Products from various Plants and Studies of TLC

1. Extraction of Nicotine alkaloid from Tobacco leaves
2. Extraction of Citral form lemongrass
3. Extraction of Caffeine from
 - Tea leaves
 - Coco
 - Coffee
4. Extraction of Chlorophyll from green leaves
5. Comparative studies of Extraction Carotene from
 - Tomato
 - Beet root
 - Carrot
6. Comparative study on extraction of Carotene by use of Different solvent(02)
7. Extraction of Cinnamaldehyde from Cinnamon
8. Isolation of Citral from Lemongrass

Laboratory Manual/ Book

1. Sharifa A. Al- Ghamdi; MahaBaljoon; *Natural Products Lab Manual*, (https://walghazzawi.kau.edu.sa/Files/0007119/Files/119837_natural_products.pdf)

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHDC603	DSE Core Practical –2: Unit Operations & Processes Practical	1 Credits - 3 hrs / wk

Objectives:

To enable the students to

- Match with the requirements at industry level
- Select the right method for crystallization
- Select the correct distillation method for liquid separation
- Convert the organic molecules

Laboratory experiments:

➤ Unit Operations

1. To determine practical yield for crystallization of Benzoic acid (By Cooling)
2. To determine practical yield for crystallization of Copper Sulphate (By evaporation)
3. To determine practical yield for crystallization of mixture of compounds (Benzoic acid + Copper Sulphate)
4. To determine practical yield for crystallization of Benzoic acid with seeding and none seeding.
5. Introduction and Demonstration of Pilot plant.
6. To calculate the average particle size and reduction ratio of
 - Jaw crusher
 - Roll crusher
 - Ball mill
7. To separate the given mixture of liquid (Polar & Non-polar solvent) by distillation.

➤ Unit Processes:

1. Preparation of Fumaric acid from Maleic acid.
2. Preparation of Benzil from Benzoin.
3. Preparation of Sulfanilic acid from Aniline
4. Preparation of p-nitro aniline from p-nitro acetanilide

Laboratory Manual/ Book

1. Reilly, M. A. *Chemical Engineering Unit Operations Laboratory Manual*. (<https://classes.engineering.wustl.edu/2009/fall/che473/files/Manual.pdf>)

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHDC604	DSE Core-Practical-2: Surface Coating Techniques	1 Credits - 3 hrs / wk

Objectives:

To enable the students to

- Electroplate various metal on different object.
- Determine various physical properties of lacquer coating bath
- Determine the amount of various metal in bath.

Laboratory experiments: (Any 12)

1. To electroplate silver on given object
2. To determine the amount of silver in silver plating bath by volumetric.
3. To determine the amount of silver metal as silver sulphide by gravimetrically.
4. To electroplate of nickel on object.
5. To determine the amount of nickel in bath.
6. To determine the amount of Ni as Nickel dimethyl glyoxime ($\text{Ni}(\text{C}_4\text{H}_7\text{O}_2)_2$) gravimetrically from the acidic solution of $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$
7. To electroplate copper on given object
8. To determine the amount of copper sulphate in copper plating bath.
9. To determine the amount of copper in copper plating bath by gravimetric analysis.
10. To electroplate chrome on given object.
11. To determine the amount of chrome in chrome plating bath.
12. To electroplate copper on given plastic object
13. To electroplate nickel on given plastic object
14. To electroplate chrome on given plastic object
15. To determine the density and refractive index of lacquer coating bath.

Laboratory Manual/ Book

1. Satas, D., Tracton, A. A., & Rafanelli, A. J. (2002, 2nd edition). *Coatings technology handbook*. CRC Press (ISBN: 0824704398)
2. Freitag, W., & Stoye, D. (Eds.). (2008, 2nd edition). *Paints, coatings and solvents*. John Wiley & Sons (ISBN: 978-3527288632)

Semester – VI		
Course Code	Course Title	Course Credit and hrs
19UCHCC606	Core-18: Group Project/Industrial training/Instrumental training	2 Credits - 4 hrs / wk

Objectives:

To enable the students to

- Improve practical skill of various industries.
- Develop skill for project writing.
- Operate and aware of various instruments.

Course Content

- The Group Project/ Industrial Training/ Instrumental Training will be offered to undergraduate students in V and VI semester. For semester-V, total 3 hrs instruction and for semester-VI total 4 hrs instruction will be allotted.
- The candidates will be given the option of selecting a Group Project/ Industrial Training/ Instrumental Training in semester V and The evaluation (Presentation & Viva) will be carried out at the end of Semester VI.
- At the end of the semester VI, the candidates have required to present their Project/ Industrial Training/ Instrumental Training report in the form of Presentation and hard copy of report submit to department.