Enclosure-VII (B)

Sarvodaya Kelavani Samaj managed,

Shri Manibhai Virani and Smt. Navalben Virani Science College

(Autonomous)

(Affiliated to Saurashtra University, Rajkot)

Re-Accredited at 'A' Level by NAAC

STAR college Scheme & Status by MST-DBT

UGC- College with Potential for Excellence (CPE)

UGC-DDU KAUSHAL Kendra

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

GPCB-Government of Gujarat approved Environment Audit Center

Nodal Center for capacity building by GSBTM

DEPARTMENT OF CHEMISTRY

SYLLABI FOR THE COURSES OF

Semester I & II

M.Sc. Chemistry (Pharma Organic Chemistry)

for students admitted from A.Y. 2019-20 & onwards

Semester - I		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC101	**Core 1: Organic Chemistry**	**4 Credits - 4 hrs / wk**

Course Description:

The course is an introduction to organic chemistry, focusing primarily on the basic principles to understand the structure and reactivity of organic molecules. Emphasis is on various reactive intermediates and some important organic reagents. The course also provides an introduction to the chemistry of aromaticity of organic compounds.

Course Purpose:

1. To understand various electronic effects and its applications on Stability, Acidity, Basicity, Nucleophilicity and Aromatic character of molecules.
2. To impart knowledge of reactive intermediates and the Hybridization, structure, generation, stability, reactivity & applications of it.
3. To familiarize students with, criteria of aromaticity, Hückel's rule, aromatic, anti-aromatic and non-aromatic compounds.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Understand concept and types of reaction mechanism, draw arrow notation, categorize bond cleavages, and generation of reactive intermediates.	K1, K2
CO_2	Understand the concept of various electronic effect and its applications.	K1, K2
CO_3	Predict the stability of reactive intermediates by applying electronic effect.	K2, K3
CO_4	Calculate aromaticity and differentiate between aromatic, anti-aromatic and non-aromatic compounds	K2, K3
CO_5	Illustrate preparation of organic reagents and recognize appropriate reagent for particular reaction.	K1, K2

Course Content **Hours**

Module-I: Electronic effects: **12 hrs**

Introduction, Temporary effect: Electromeric (Mesomeric) effect, Permanent Effects: Inductive effect, Resonance effect, Hyperconjugation effect and its applications (Stability, Acidity, Basicity, Nucleophilicity, Aromatic character).

Module-II : Reactive Intermediates-I: **14 hrs**

Homolytic and Heterolytic fission, Different types of arrow notation, concept and examples of Electrophiles and Nucleophiles. Hybridization, structure, generation, stability, reactivity & applications of Carbocation and Carbanion.

Module-III : Reactive Intermediates-II: **14 hrs**

Hybridization, structure, generation, stability, reactivity & applications of Free radicals, Carbenes, Nitrenes, Ylides, Benzyne and Enamines.

Module-IV : Aromaticity: **10 hrs**

Introduction, criteria of aromaticity, Hückel's rule, examples of aromatic, anti-aromatic and non-aromatic compounds. Aromatic character for annulenes, azulenes & heterocycles.

Module-V : Organic reagents: **10 hrs**

Structure, properties, synthesis and applications of:
(1) DDQ, (2) Dicyclohexylcarbodimide (DCC), (3) Lithium diisopropylamide (LDA), (4) $LiAlH_4$ (LAH), (5) *m*-Chloroperbenzoic acid (MCPBA) (6) N-Bromosuccinimide (NBS), (7) TBAB (Quaternary Ammonium salt), (8) Woodward & Prevost Hydroxylation.

Suggested laboratory experiments:

- Note: Included in core practical-1

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.

Reference Books:

1. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. Morrison & Boyd (2009, Sixth edition) *Organic Chemistry*. New Jersey: Pearson Education (ISBN: 978-81-7758-169-0).McMurry, John E. (2011, Eight edition) *Organic Chemistry*. Boston: Cengage Learning (ISBN: 0840054440).
3. Smith, Michael B.; March, Jerry (2013, Seventh edition) *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*. Hoboken: Wiley-Blackwell (ISBN: 978-0-470-46259-1).
4. Bansal, Raj K. (2009, Fifth) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8).
5. T. W. Graham Solomons (2011, 10th edition) *Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).

Laboratory Manual/ Book

- Not applicable.

Suggested reading / E-resources

- Organic Journal

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					**40**

Semester - I		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC102	**Core 2: Analytical Chemistry**	**3 Credits - 3 hrs / wk**

Course Description:
The course nature is fundamental analytical chemistry, focusing primarily on fundamental of analytical methods, chemical calculations, green analytical techniques, various extraction techniques and inters Intellectual Property Rights (IPR).

Course Purpose:
- To understand fundamental concepts of classical and instrumental methods of analysis.
- To develop an understanding of different stochiometric calculations and various extraction techniques.
- To familiarize students with the principle of green chemistry and its application for the sustainable development.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Differentiate basic analytical techniques and apply for various chemical analysis.	K1, K2
CO_2	Calculate modes of concentration for chemical analysis.	K2, K3
CO_3	Apply green chemistry approach for the sustainable development.	K3, K4
CO_4	Understand the different terms and criteria of Intellectual Property right	K1, K2
CO_5	Employ appropriate extraction methods for the chemical separation.	K3, K4

Course Content **Hours**

Module-I : Fundamentals of analytical chemistry: **10 hrs**

Definitions, classification of analytical techniques and its importance. Types and application of quantitative analysis, Selection of analytical method, Gravimetric and volumetric analysis, Classical and instrumental techniques, Types of Instrumental analysis, Factors affecting the analytical method, Law of mass action, Safety in analytical laboratory

Module-II : Chemical calculations: **10 hrs**

Concentration units (Molarities, Normality, Formality, ppb, ppm, mole calculation, Empirical Formulas, % composition, Determination of molecular weight, theoretical yield, Percent Yield) calibrations in laboratory practice, standardization.

Module-III : Green Analytical Chemistry: **10 hrs**

Introduction, 12 principles of green chemistry, Green technology and process, Application of green Chemistry for sustainable development.

Module-IV : Extraction Techniques **08 hrs**

Introduction, theory, types of extraction (LLE, SSE, LSE), Different extraction methods (Maceration, Infusion, Digestion, Decoction, Percolation, Solvent extraction, Soxhlet Extraction, Counter current extraction, Sonication, Supercritical fluid extraction, Steam distillation), Application.

Module-V : Intellectual Property Rights (IPR): **07 hrs**

Introduction, various Technical Terms, Legislation, IPA in India, Criteria for Patent, Patent for Polymorph.

Suggested laboratory experiments:

- Note: Included in core practical-1

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.

Reference Books:

1. B. K. Sharma. "Instrumental method of chemical analysis" **24th** edition**,** GOEL publishing house Meerut. 2005
2. Fundamentals of Analytical Chemistry by Skoog Douglas A.
3. Instrumental Methods of Analysis by B. Sivasankar
4. Gary D. Christian. " Analytical chemistry" **6th** edition John Wiley & sons, Inc. 2004
5. Skoog, Holler, Niemon, "principles of instrumental analysis" **5th** edition, Saunders college publisher.
6. Analytical Chemistry by Chatwal G. R.
7. Analytical Chemistry: Theory and Practice by Verma R. M.

Laboratory Manual/ Book

- Not applicable

Suggested reading / E-resources

- E-Journals

Suggested MOOCs

- NA

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					**40**

Semester - I		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC103	**Core 3: Inorganic Chemistry**	**4 Credits - 4hrs / wk**

Course Description:

The course inorganic chemistry includes stereochemistry and bonding of compounds, introduction of transition elements and theory of Coordination Compounds. It also includes concept of crystal field theory, symmetry and point group theory and basics of organometallic complexes.

Course Purpose:

- To understand the bonding concepts that explains the structures of both main group and transition elements.
- To calculate coordination number and spectral term symbol for coordination compounds.
- To apply the knowledge of CFT for different shapes of complexes and illustrate character table for point groups.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Predict bond order & shapes of covalent compounds using MO & VB theories.	K1, K2
CO_2	Classify coordination compounds & predict isomerism, coordination number, shapes and spectral term symbol for coordination compounds.	K1, K2
CO_3	Understand and apply CFT for splitting of d-orbitals in octahedral, tetrahedral and square planner complexes.	K1, K2
CO_4	Determine symmetry elements and their point groups of molecules by point group theory	K4
CO_5	Recognize bonding, synthesis and application of organometalic complexes.	K1, K2

Course Content **Hours**

Module-I : Stereochemistry and Bonding in compounds **12 hrs**

Valance bond theory, Types of overlapping, Molecular orbital theory, Bond order, Factor affecting on Bond length (Bond strength), Homonuclear diatomic molecules, Heteronuclear diatomic molecules, Shapes of covalent compounds, VSEPR, Hybridization.

Module-II : Transition Elements & Coordination Compounds **12 hrs**

Classification of Coordination compounds, Werner's theory, Nomenclature, Isomerism, Coordination number, structures and shapes, electronic spectra (spectroscopic terms, term symbols, calculation of spectroscopic terms).

Module-III : Crystal Field Theory **14 hrs**

Concept of crystal field theory, Crystal Field Splitting of d-orbitals (Octahedral, tetrahedral and square planner complexes with CFSE concept), Factors affecting the value of Δ_0, High spin and Low spin complexes, Td distortion, Jahn-Teller effect, splitting of d and f ground terms and its orgel diagram, Example based on CFSE, Pairing energy and magnetic momentum.

Module-IV : Symmetry and Point Group Theory **12 hrs**

Symmetry elements and Operations, Point groups and their symmetry elements, Properties and representation of Groups (Matrices, Representation of point groups, character table). Examples and application of symmetry.

Module-V : Organometallic Complexes **10 hrs**

Introduction, Structure & Classification, 18 electron rule, hepticity, ligands in organometallic chemistry, Metal-Carbonyl and clusters, Organometalic catalysis: Hydroformylation, Monsanto acetic acid process, Wacker (Smidt) process, Wilkinson's catalyst, Mond process.

Suggested laboratory experiments:

- Note: Included in core practical-1

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.

Reference Books:

1. Agarwala S. K.; Lal K. (2009), *Advanced Inorganic Chemistry*, Meerut (ISBN: 978-81-8398-773-8).
2. Miessler, G. L; Fischer, P. J.; Tarr, D. A. (2014, sixth edition) *Inorganic Chemistry.* Library of Congress Cataloging-in-Publication Data (ISBN: 978-0-321-81105-9).
3. Prasad, R. K. (2004, Second edition) *Quantum Chemistry*. New Delhi: New Age International (P) Ltd. (ISBN: 81-224-1264-5).
4. Chandra, A. K. (2008, Fourth edition) *Introductory Quantum Chemistry*, New Delhi: Tata McGraw-Hill. (ISBN: 0-07-462054-1).
5. Singh, A.; Singh, R. (2005) *Textbook of Inorganic Chemistry Vol. I & II*. New Delhi: Campus Books International (ISBN: 8180300714).
6. Mehrotra, R. C. and Singh, A. (2004, Second edition) *Organometalic Chemistry A*

Unified Approach, New Delhi: New Age International (P) Ltd. (ISBN: 81-224-1258-05).

Laboratory Manual/ Book

- Not applicable

Suggested reading / E-resources

- NA

Suggested MOOCs

- NA

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					**40**

Semester - I		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC104	**Core 4: Physical Chemistry**	**3 Credits - 3hrs / wk**

Course Description:
This course provides a basic understanding of the core area of physical chemistry, based around chemical kinetics, properties of solutions, Free Energy and Chemical Reactions, Homogeneous & Heterogeneous Catalysis and polymer chemistry.

Course Purpose:
- To identify the order of reaction by using concepts of chemical kinetics.
- To understand fundamentals of solutions and its deviation from ideal behaviour.
- To apply the concept of catalyst and identify polymers by employing analytical methods.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Recall types & order of chemical reaction	K1
CO_2	Understand properties & behavior of ideal, non-ideal and dilute solutions	K1, K2
CO_3	Distinguish Free energy change and its applications in chemical reactions	K2, K3
CO_4	Classify the types, characteristics and mechanism of homogeneous & heterogeneous catalysis.	K2, K3
CO_5	Derive synthesis of polymers and its identification by different techniques.	K2, K3

Course Content **Hours**

Module-I : Chemical kinetics: **10 hrs**

- Introduction of Chemical kinetics, Types of reaction: reversible reaction, opposite reaction, successive reaction, consecutive reaction, simultaneous reaction, parallel reaction, order of reaction, zero order, First order reaction in solution, Pseudo unimolecular reaction, Second order reaction, Pseudo Bimolecular reaction, Third order reaction, n^{th} order, molecularity with example, Effect of temperature on rate of reaction, Temperature coefficient, Arrhenius equation, the temperature dependence reaction rates, Interpretation of Arrhenius parameters, Activation energy, Collision

theory.

Module-II : The Properties of Solutions: **10 hrs**

Ideal solutions: Properties, the Duhem-Margules equation, vapour pressure curves. Composition of liquid and vapour in equilibrium influence of temperature on gas solubility and solid-liquid equillibria.

Non ideal solutions: Deviation from ideal behavior, vapour pressure curves, liquid and vapour compositions. General equations for liquid mixtures, partially miscible liquids

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

Module-III : Free Energy and Chemical Reactions **10 hrs**

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

Module-IV : Homogeneous & Heterogeneous Catalysis **08 hrs**

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

Module-V : Polymer Chemistry **07 hrs**

- Introduction & classification of polymers, synthesis of some general polymers, identification of polymer: chemical analysis, spectroscopic methods, X-ray diffraction and, thermal analysis.

Suggested laboratory experiments:

- Note: Included in core practical-1

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.

Reference Books:

1. Glasstone, Samuel. (2007) *Thermodynamics for Chemists*: Narahari Press (ISBN: 1406773220).

2. Peter Atkins, Julio de Paula (2015) Physical chemistry: Thomson Press (ISBN: 019872872-7).
3. Gurdeep Raj (2014, Third edition) *Thermodynamics*. Meerut: GOEL publishing House (ISBN: 8187224886).
4. Gurtu, J. N. Gurtu, A. (2014, Twelfth edition) *Advanced Physical Chemistry*. Meerut: Pragati Prakashan (ISBN: 9350060191).
5. Barrow, Gordon M. (1996, Sixth edition) *Physical Chemistry*. New York: McGraw-Hill International. (ISBN: 0070051119).
6. V R Gowariker, (2012) Polymer *Chemistry*. New age International P limited. (ISBN: 978-0-85226-307-5).

Laboratory Manual/ Book

- Not required

Suggested reading / E-resources

- NA

Suggested MOOCs

- NA

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					**40**

Semester – I		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC105	**Practical Core 1 & 2: Organic & Analytical Chemistry**	**3 Credits - 6 hrs / wk**

Course Description:
This course provides practicals of separation and qualitative analysis of organic mixtures. The course also includes preparation and calibration of solutions used everyday in laboratory.

Course Purpose:
- To separate organic ternary mixtures and identify the unknown compounds by qualitative tests.
- To prepare and standardize solution used in routine laboratory practical.
- To extract and isolate chemical constituents from the mixture.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Perform Qualitative Analysis of a ternary organic mixture	K3,K4
CO_2	Prepare and standardize the solutions.	K2, K3
CO_3	Demonstrate Calibration of glassware and apparatus.	K3
CO_4	Measure the Assay and % Purity of fine chemicals.	K2
CO_5	Employ appropriate extraction methods for the chemical separation	K4,K5

Course Content **Hours 6 hrs / practical**

1. **Organic Chemistry:**
    - Ternary Mixture Separation & Qualitative analysis.

2. **Analytical Chemistry:**
    - Preparation and standardization of solutions.
    - Calibration of glassware and apparatus.
    - Assay & % Purity of chemicals.
    - Extraction.

Suggested laboratory experiments:
- Not applicable

Pedagogic tools:
- NA

Reference Books:

1. Brian S. Furniss (1989, Fifth edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).

Laboratory Manual/ Book

- NA

Suggested reading / E-resources

- NA

Suggested MOOCs

- NA

Methods of assessing the Course Outcomes

The COs of the course will be assessed through

- CIA and SEE

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test	50% to 60 % of Experiment	3 hrs	30	30
2.	Observation book & Record	-	-	10	10
Total					**40**

Semester - I		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC106	**Practical Core 3 & 4: Inorganic & Physical Chemistry**	**3 Credits - 6 hrs / wk**

Course Description:

This course provides qualitative analysis of inorganic mixtures including one less common / rare metal ion. The course also deals with estimation of various physical parameters by instrumental and conventional methods.

Course Purpose:

- To separate and identify inorganic ternary mixtures by qualitative tests.
- To estimate various physical parameters using different instruments and classical titrimetric method.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Perform Qualitative Analysis of an inorganic mixture containing six radicals.	K3, K4
CO_2	Utilize Conductivity meter, pH & Potentiometer, Refractometer, and Ultrasonic instrument for physicochemical analysis.	K2, K3
CO_3	Demonstrate experiments on Partition Co-efficient, First and second order reactions-order determination, energy of activation, Heat of vaporization, Partial molar volume.	K3, K4

Course Content **Hours**

1. **Inorganic Chemistry:** **6 hrs / practical**

   Qualitative Analysis: Analysis of a mixture containing six radicals including one less common / rare metal ion.

2. **Physical Chemistry:**

   - **Conductometry:** Mono and biprotic acids, mixtures of acids against strong/weak bases, hydrolysis constant, verification of Onsagar's equation
   - **pH metry**: Quantitative drug analysis, Hemmet constant, hydrolysis constant of electrolytes, acid-base titration, pKa of acids.
   - **Refractometry**: Molar refraction, refractive index, composition of Binary mixtures.
   - **Potentiometry**: Acid-base, normality and dissociation constant,

Redox and Argentometric titrations.

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

Suggested laboratory experiments:

- Not applicable

Pedagogic tools:

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Reference Books:

1. Svehla, G. (1996, Seventh edition) *Vogel's Qualitative Inorganic Analysis*. New Jersey: Pearson Education. (ISBN: 0582218667).
2. Parsania P. H (2005, 1st edition) Experiments in Physical Chemistry, Granth Nirman Board.

Laboratory Manual/ Book

- Not applicable.

Suggested reading / E-resources

- NA

Suggested MOOCs

- NA

Methods of assessing the Course Outcomes

The COs of the course will be assessed through

- CIA and SEE

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test	50% to 60 % of Experiment	3 hrs	30	30
2.	Observation book & Record	-	-	10	10
Total					**40**

Semester - II		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC201	**Core 5: Separation Techniques**	**4 Credits - 4 hrs / wk**

Course Description:

Thorough familiarization of students with chromatography as an analytical technique for separation, isolation and identification of organic/natural compound from multi-component mixtures. The course gives a theoretical as well as a practical introduction to principles and techniques of chromatography: adsorption and partition chromatography (normal and reversed-phase systems), thin layer chromatography (TLC), column liquid chromatography including HPLC, gas chromatography, ion exchange and size exclusion chromatography.

Course Purpose:

- To Understand concept, types, instrumentation and applications of various planner and column chromatography techniques.
- The course provides hands-on training on TLC and Column.
- Demonstrative training of sophisticated instruments like HPLC and GC.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Understand the principle, fundamental theory and instrumentation of various planar and column chromatographic techniques.	K1, K2
CO_2	Identify the significance, quality, and limitations of the results produced by the various separation techniques.	K2, K3
CO_3	Apply theoretical knowledge to design and develop suitable operating conditions for separation and identification of organic/natural compounds from multi-component mixtures	K4
CO_4	Calculate Rf values and Interpret HPLC and GC chromatograms to perform qualitative analysis of unknown	K3, K4
CO_5	Differentiate various applications of separation techniques to medicinal and pharmaceutical field.	K4

Course Content **Hours**

Module-I: Introduction and Basic Theory of Chromatography: 12 hrs

Introduction, history, principle, different terms in chromatography, basic theory, classification based on SP, MP, and attractive force (adsorption, partition, ion exchange and size exclusion), plate theory, rate theory & applications.

Module-II: Column Chromatography: **12 hrs**

Principle, basic theory of manual column, Adsorbent, types of column chromatography, manual techniques, Advantage and disadvantage
Ion-exchange chromatography: Principle, Theory, Ion exchangers, Effective parameter and Application
Affinity chromatography: Principle, Theory, Applications.

Module-III : Planar Chromatography (TLC & HPTLC): **12 hrs**

Thin Layer chromatography (TLC):
Principle, basic theory, techniques of TLC, Argentometric chromatography, mode of TLC, 2D-TLC and application
High Performance thin layer Chromatography (HP-TLC):
Principle, Theory, Instrumentation and application

Module-IV : Gas Chromatography (GC): **12 hrs**

Introduction and definition of GC and HSGC
GC: Principle, working theory, instrumentation and applications
GC-MS: Principle, working theory and applications

Module-V : Liquid Chromatography (HPLC): **12 hrs**

Introduction and definition of terms HPLC, UPLC, OPLC
HPLC: Principle, working theory, instrumentation and applications
LC-MS: Principle, working theory and applications

Suggested laboratory experiments:

- **Note:** Included in Practical Core 5 & 6:

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.
- Live Demonstration of Instruments

Reference Books:

1. Analytical Chemistry by Christian Gary D.
2. Fundamentals of Analytical Chemistry by Skoog Douglas A.
3. Sethi, P. D. (2013) Sethi HPTLC: High Performance Thin Layer Chromatography: Quantitative Analysis of Pharmaceutical Formulations 3 Volume Set. New Delhi: CBS Publishers & Distributors Pvt. Ltd. (ISBN: 9788123922799).
4. Stahl, E. (1969, Second edition) Thin-Layer Chromatography: A Laboratory Handbook. New Berlin: Springer. (ISBN: 978-3-642-88488-7).
5. Separation techniques by Satyender Ahuza.
6. Instrumental Methods of chemical analysis by B.K. Sharma.
7. Pharmaceutical analysis (Vol.II) Dr. A. V. Kasturie, Dr. S.G. Wadodkar.
8. Instrumental Methods of chemical analysis Gurdeep R. Chatwal.
9. H.A. strobe chemical instrumental A schematic Approach 2nd Edition, Addison Wesely, Reading mass.

Laboratory Manual/ Book

- Not applicable.

Suggested reading / E-resources

- http://www.nptel.ac.in/courses/104103069/#
- http://ocw.mit.edu/courses/chemistry/
- Part A (Journal of Chromatography Library). Philadelphia: Elsevier Publishing Company. (ISBN: 0444511075).
- Journal of Planar chromatography (JPC)

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					40

Semester - II		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC202	**Core 6: Organic Reactions & Rearrangements**	**3 Credits - 3 hrs / wk**

Course Description:

Organic Reaction and Rearrangements is a step by step description of a sequence of basic reactions through which the overall chemical change occurs. Which bonds brakes, which forms, in which sequence, how many steps are involved and relative rates of each such steps are the details one can obtain through the study of reaction mechanism.

Course Purpose:

- To understand concept and types of reaction mechanism.
- To determine the stability of reactive intermediates.
- To understand Principle, plausible reaction mechanism and applications of various organic named reactions.
- To understand concept of molecular rearrangement and its applications in organic synthesis.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Understand concept and types of reaction mechanism draw arrow notation, categorize bond cleavages.	K1, K2
CO_2	Extend concept of molecular rearrangement and describe plausible reaction mechanism mentioning its applications in organic synthesis.	K1, K2
CO_3	Describe Principle, plausible reaction mechanism and applications of various organic reactions.	K2, K3
CO_4	Identify suitable starting material, reagent and reaction condition or product for given organic transformations.	K3
CO_5	Apply concept of various reaction and rearrangements to predict plausible product(s).	K3, K4

Course Content **Hours**

Module-I: Reaction based on Reactive Intermediates-1: **10 hrs**

Principal, mechanism and applications:

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

Module-II : Reaction based on Reactive Intermediates-2: **10 hrs**

Principal, mechanism and applications:

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

Module-III : Reaction based on Cyclization: **10 hrs**

Principal, mechanism and applications:

- **Carbocylic formation**: Robinson annulation, Danishefsky's diene cycloaddition.
- **Heterocyclic formation**: Fischer indole, Knorr pyrrole, Von Pechman reaction.
- **Pericylic and metathesis**: Diels alder cycloaddition, Hetero Diels alder, Aza-Cope rearrangement, Claisen rearrangement, alkene and alkyne (Enyne) metathesis.

Module-IV : Multicomponent Reactions: **07 hrs**

Principal, mechanism and applications: Ugi, Biginelli, Hantzsch dihydropyridine, Mannich reaction.

Module-V : Cross coupling Reactions: **08 hrs**

Pd-catalyzed cross coupling reaction: Suzuki, Sonogashira, Heck, Negashi, Kumada, Stille, Buchwald-Hartwig reaction.

Suggested laboratory experiments:

- Note: Included in practical Core -5 & 6.

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.

Reference Books:

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

John Wiley & Sons, Inc.

Laboratory Manual/ Book

- Not applicable.

Suggested reading / E-resources

- https://www.organic-chemistry.org/reactions.htm
- https://www.masterorganicchemistry.com/reaction-guide/

Suggested MOOCs

- Organic Reactions-Swayam
- Organic Reactions-NPTEL

Methods of assessing the Course Outcomes

- **Continuous Internal Assessment (CIA)**
- **Semester End Evaluation (SEE)**

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					40

Semester II		
Course Code	**Course title**	**Course Credit and hrs.**
19PCHCC203	**Core 7: Stereochemistry**	**3 Credits - 3 hrs./Wk**

Course Description:

Stereochemistry of molecules dictates isomerism, chemical and biochemical reactivity. These days, chiral drugs have become an integral part of pharmaceutical industry. A basic concept on 3D structures, different projection formula, conformations of molecules and asymmetric synthesis and other stereochemical principles and attributes are essential. This course will lay the foundation on to which further advanced topics can be built up.

Course Purpose:

1. To understand and describe Fundamental of Stereochemistry.
2. To discuss Prochirality and Asymmetric Synthesis.
3. To describe Conformational Analysis & Reactivity.
4. To describe Stereochemistry of Substitution, Elimination Reactions and addition reactions.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Understand the fundamentals of stereochemistry and able to draw stereoisomers of organic compounds, and recognize diastereomers, enantiomers, meso compounds and centres of symmetry.	K1, K2
CO_2	Able to discuss the relative stability of conformational isomers of cyclohexanes and related compounds.	K1, K2
CO_3	Recognize and discuss the stereoisomers of chiral compounds that do not contain a stereogenic carbon centre and assign the configuration of the stereoisomer.	K2, K3
CO_4	Understand and identify the Substitution Nucleophilic (SN1, SN2, SNi & Mixed SN1 & SN2) and Elimination reaction (E1, E2 and E1cB) mechanism and stereochemistry and Addition Reactions to Carbon-Hetero multiple bond.	K1, K2, K3
CO_5	Apply the stereochemistry concept to identify configuration, conformation, stereochemical notations, Nucleophilic substitution, elimination, reduction and addition reactions to Carbon-Hetero multiple bond.	K2, K3, K4

Course Content

Module-I: Fundamental of Stereochemistry: 10 Hrs

Chirality, Isomers, Classification of stereoisomerism, Optical isomerism, Conventions for D, L and R, S- system, Inter-conversion between Fischer and Three-dimensional formulas with one stereo center, Stereoisomerism for more than

one stereogenic unit, Threo & Erythro, Geometrical isomerism, Cis/Trans, E-Z isomerism resulting from double bonds, Oximes, Racemic mixtures and Racemization, Resolution of racemic mixtures, Optical purity & Enantiomeric excess, Formation of diastereomers, Stereoselective and stereospecific reactions, Stereoisomerism without a stereogenic carbon (axial chirality), Planar chirality, Helicity and Molecular stereoisomerism.

Module-II: Prochirality and Asymmetric Synthesis: 08 Hrs

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

Module-III: Conformational Analysis & Reactivity: 10 Hrs

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

Module-IV: Stereochemistry of Substitution & Elimination Reactions: 08 Hrs

- **Aliphatic Nucleophilic Substitution Reactions**: Introduction, stereochemistry of SN1 & SN2 reaction mechanism, The SNi mechanism, Mixed SN1 & SN2 reaction, ambident nucleophile, Regioselectivity, Neighboring group participation.
- **Stereochemistry of Elimination Reactions:** Introduction, Mechanism E1, E2 and E1cB, Stereochemistry of E2-anti-ellimination reaction, E2-syn-elimination, Orientation of the double bond, Pyrolytic elimination.

Module-V: Stereochemistry of Addition Reactions to Carbon-Hetero multiple bonds: 09 Hrs

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

Suggested laboratory experiments:

- Included in core practical-7

Pedagogic tools:

- Chalk and Board, Stick-ball 3D models, direct explanation.
- Power point presentation, LCD and Videos.

Reference Books:

1. Kalsi, P. S. (2012, Fourth edition) *Organic Reactions Stereochemistry and Mechanism (Through Solved Problems)*. New Delhi: New Age International (P) Limited. (ISBN: 9788122417661).
2. Kalsi, P. S. (2011, Seventh edition) *Stereochemistry Confirmation and Mechanism*. New Delhi: New Age International (P) Limited. (ISBN: 81-224-2356-6).
3. Nasipuri, D. (2011, Third edition) *Stereochemistry of Organic Compounds: Principles and Applications*. New Delhi: New Age International (P) Limited. (ISBN: 978-81-224-3029-5).
4. Finar, I. L. (1989, Fifth edition) *Organic Chemistry: Vol -2: Stereochemistry and the Chemistry of Natural Products*. Harlow: Longman. (ISBN: 0-582-05916-X).
5. Clayden Jonathan; Greeves Nick, Warren Stuart (2012, Second edition) *Organic Chemistry*. Oxford: Oxford University Press (ISBN: 0199270295).
6. Eliel, Ernest L., Wilen, Samuel H. (1994) *Stereochemistry of Organic Compounds*. Hoboken: Wiley-Blackwell (ISBN: 0471016705).
7. Nogradi, M. (2008, Second revised and updated edition) *Stereoselective synthesis: A practical approach*. Weinheim: Wiley VCH. (ISBN: 978-3-527-61568-1).

Laboratory Manual/ Book

- Not applicable.

Suggested reading / E-resources

- https://www.khanacademy.org/science/organic-chemistry/stereochemistry-topic

Suggested MOOCs

- Stereochemistry- NPTEL
- Stereochemistry- Swayam

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					40

SEMESTER II		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC204	**Core 8: Modern Analytical Techniques**	**3 Credits - 3 hrs / wk**

Course Description:

This course focuses on several topics in Modern analytical techniques and will contain: principles, theory, instrumentation and Identification of molecules and materials with advanced spectroscopy and spectrometry such as UV-Vis spectroscopy, FT-IR spectroscopy, Mass Spectrometry, ^{1}H, ^{13}C NMR and 2D NMR spectroscopy.

Course Purpose:

1. To understand and describe Fundamental of Modern Analytical Techniques.
2. To have a basic understanding of the theoretical background of the measurement principles typically used in spectroscopy and spectrometry.
3. To discuss instrumentation of UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry.
4. To be able to develop an analytical strategy to interpret an unknown organic compounds.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Understand Principle and theory of various spectroscopy. i.e. UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry.	K1, K2
CO_2	Discuss Instrumentation of UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry.	K2, K3
CO_3	Demonstrate competence in collecting and interpreting data in the laboratory.	K4
CO_4	Solve problems related to the saturation, functional group, molecular weight and structure of molecules	K3, K4
CO_5	Analyze and interpret spectroscopic data for structure elucidation.	K4, K5

Course Content

Module-I. Introduction to Spectroscopic Techniques: 09 Hrs

Types of Analytical techniques, Introduction of Instrumental methods and its classification, Overview of spectroscopic methods based on wave length regions of Electromagnetic radiation, Properties of Electromagnetic radiation.

UV-Visible Spectroscopy: Introduction to UV and Visible, Principle & Theory of UV spectrometry, Instrumentation, Interpretation of UV spectra, Applications UV spectroscopy.

Module-II. Infrared Spectroscopy : 07 Hrs

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

Module-III. Mass Spectroscopy: 09 Hrs

Introduction, Principle, Theory and components of mass spectrometers, Different ionization and detection techniques, recording and resolution of mass spectrometer, Types of ions produced in mass spectrometer, Interpretation of Mass spectra of selected organic compounds / API, Applications of Mass spectrometry.

Module-IV. Nuclear Magnetic Resonance Spectroscopy-I: 10 Hrs

Introduction, NMR active nuclei, Basic Theory, NMR Spectrometer, internal Standard & solvent; **^{1}H NMR (PMR):** Principle, Number of PMR Signals: Equivalent and Nonequivalent Protons, Shielding, Deshielding and Chemical shift, Magnetic anisotropy, Factors affecting on chemical shift, Peak area and Proton counting, spin-spin coupling (multiplicity), coupling constant (J), Nomenclature of Spin Systems, applications & problems of Nuclear magnetic resonance spectroscopy.

Module-V. Nuclear Magnetic Resonance Spectroscopy-II: 10 Hrs

^{13}C NMR: Introduction, Principle, Chemical shift, Application and Problems of ^{13}C NMR Spectroscopy, DEPT; **2D NMR**: Introduction of Homonuclear Correlation Spectroscopy (COSY, TOCSY, NOESY and INADEQUATE), Heteronuclear Correlation Spectroscopy (HSQC, HMQC and HMBC).

Suggested laboratory experiments:

- Note: Included in core practical-8

Pedagogic tools:

- Chalk and Board, Power point presentation, models
- LCD and Videos.

Reference Books:

1. Savant, M. M, Khistariya, A. V. (2017, First edition) *Spectroscopy*. Bharat Publishing House, Rajkot (ISBN: 978-93-5236-290-5).
2. Yadav, L. D. S. (2005) *Organic spectroscopy*. Springer-Science + Business Media, B.V. (ISBN 978-94-017-2508-8).
3. Field, L. D., Li, H. L., Magill, A. M. (2015, First edition) *Organic Structures from 2D NMR Spectra.* John Wiley & Sons Ltd, (ISBN: 9781118868942).

4. Jacobsen, N. E. (2017) *NMR Data Interpretation Explained.* John Wiley & Sons Ltd, (ISBN: 9781118370223).
5. Pavia, Donald L., Lampman, Gary M., Kriz, George S. Vyvyan, James A. (2015, Fifth edition) *Introduction to Spectroscopy*, Cengage Learning, USA. (ISBN: 9781285460123).
6. Silverstein, Robert M., Webster, Francis X., Kiemle, David J., Bryce, David L. (2014, Eighth edition) *Spectrometric identification of Organic Compounds*. John Wiley & Sons Ltd. (ISBN: 978-0-470-91401-4).
7. Williams, D. H., Fleming, I. (2007, Sixth edition) *Spectroscopic Methods in Organic Chemistry*. New Delhi: Tata McGraw-Hill. (ISBN: 007711812X).
8. Kalsi, P. S. (2006, Sixth edition) *Spectroscopy of Organic Compounds*. New Delhi: New Age International Pvt. Ltd. (ISBN: 8122415431).

Laboratory Manual/ Book

- Not applicable

Suggested reading / E-resources

- E-Journal of spectroscopy
- Libgen
- Khan academic

Suggested MOOCs

- Spectroscopy: Swayam portal

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test-I	Two Modules	1.5 hrs	5 (Set for 30)	20
	Test-II	All modules	3 hrs	15 (Set for 60)	
2	Assignment	-	-	10 (Mark on 20)	20
3	Class Activity	-	-	10	
Total					**40**

Semester - II		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC205	**Practical Core 5 & 6: Separation Techniques & Organic Synthesis**	**3 Credits - 6 hrs / wk**

Course Description:

Thorough familiarization of students with chromatography as an analytical technique for separation, isolation and identification of organic/natural compound from multi-component mixtures.

Organic synthesis is focusing primarily on the basic principles to understand the structure and reactivity of organic molecules. The purification technique of the obtained crude product is essential to get analytically pure compounds.

Course Purpose:

- To understand techniques of separation using various chromatographic techniques.
- To carry one or multi step reaction for organic transformations.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Design and develop solvent system for separation and identification of organic/natural compounds from multi-component mixtures.	K3, K4
CO_2	Construct manual Thin layer chromatography and Column chromatography and Demonstration of HPLC and GC-Mass spectrometer.	K4
CO_3	Demonstrate laboratory setup for various reactions conditions.	K2
CO_4	Apply understanding of reaction mechanism and reagents to perform organic preparation.	K3, K4
CO_5	Analyze product formation by using physical measurement, separation and purification techniques.	K4

Separation Techniques Practical:

1. **Separation Techniques:**
    - Separation of Amino acid by using Paper Chromatography (05 Exercise)
    - Separation of organic/Natural mixture by using Thin Layer chromatography (04 Exercise)
    - Separation of organic/Natural mixture 2D TLC (01 Exercise)

- Separation of Inorganic mixture and Natural product by using Column chromatography (02 Exercise)

2. **Organic Synthesis:** One or Two step organic preparation of important intermediates/privilege scaffolds. (12 Exercise)

Suggested laboratory experiments:

- Not applicable

Reference Books:

- Not applicable

Laboratory Manual/ Book

- Thin-layer chromatography: A laboratory handbook (*Stahl*, Egon).
- Practical organic chemistry by A. I. Vogel.

Suggested reading / E-resources

- Not applicable

Suggested MOOCs

- Not applicable

Methods of assessing the Course Outcomes

- Continue Internal Assessment (CIA)
- Semester End Examination (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test	50 to 60% of Experiment	2/3 hrs	30	30
2.	Observation book & Record	-	-	10	10
Grand Total					**40 Marks**

Semester - II		
Course Code	**Course Title**	**Course Credit and hrs**
19PCHCC206	**Practical Core 7 & 8: Stereochemistry & Modern Analytical Techniques**	**3 Credits - 6 hrs / wk**

Course Description:

The aim of the experiment is to learn concept of stereochemistry and find out optical activity of pure stereoisomer's and recemic mixture. Learn the basic principles of UV-visible spectrophotometry and how to measure wave length and concentration by a UV-visible spectrophotometer. The importance of infrared spectroscopy to find various functional groups encountered in the study of structure of organic compounds

Course Purpose:

1. To understand and apply stereochemistry concept to determine configuration of stereoisomers.
2. To handling polarimeter , UV-visible and IR spectrophotometer.
3. To learn proper sample handling procedures for acquiring infrared and UV spectra.
4. To identify a compound by an investigation of its infrared spectrum
5. To determine the percentage composition of a liquid sample mixture by the application of Beer's law.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K1 to K6)**
CO_1	Apply the stereochemistry concept to identify optical activity of pure stereoisomers and recemic mixture	K2, K3
CO_2	Calculate enantiomeric excess of recemic mixture.	K3
CO_3	Apply UV Viz. phenomena to find out wavelength, concentration and chemical shifts of organic molecules.	K3, K4
CO_4	Interpret IR spectrum for identification of various functional group in organic molecules.	K3, K4
CO_5	Operate polarimeter, UV Visible and IR spectrophotometer.	K4

Practical Core 7 : Stereochemistry

1. Find out optical activity of pure stereoisomers. (04 Exercise)
2. Determination of optical activity of recemic mixture.
    - D Glucose and L-Glucose (01 Exercise)
    - D-Amino acids and L-Amino acids (04 Exercise)

3. Determination of enantiomeric excess of recemic mixture. (03 Exercise)

Practical Core 8: **Modern Analytical Techniques**

1. **UV-VIZ. Spectroscopy:**
    - Find out Wavelength selected Organic molecules/ APIs (02 Exercise)
    - Concentration selected Organic molecules/ APIs (02 Exercise)
    - Shifts of selected Organic molecules/ APIs (02 Exercise)
2. **IR Spectroscopy:**
    - Carry out IR spectrum and interpretation of selected organic molecules / APIs (06 Exercise)

Suggested laboratory experiments:

- Not applicable

Reference Books:

- Not applicable

Laboratory Manual/ Book

- Practical organic chemistry by A. I. Vogel.

Suggested reading / E-resources

- Not applicable

Suggested MOOCs

- Not applicable

Methods of assessing the Course Outcomes

- Continue Internal Assessment (CIA)
- Semester End Examination (SEE)

Component of CIA

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test	50 to 60% of Experiment	2/3 hrs	30	30
2.	Observation book & Record	-	-	10	10
Grand Total					**40 Marks**