BANKURA UNIVERSITY

(West Bengal Act XIX of 2013- Bankura University Act, 2013)

Main Campus, Bankura Block-II, P.O.: Purandarpur, Dist.: Bankura, Pin- 722155, West Bengal

Office of the Secretary

Faculty Council for Undergraduate Studies

Ref: BKU/FCUG/52/2024 Date: 04/04/2024

NOTIFICATION

As directed, the undersigned is pleased to inform all concerned that Bankura University has initiated the process to implement New Curriculum and Credit Framework for Undergraduate Programme, UGC 2022 (as per NEP 2020) for 4-years Undergraduate programme with Chemistry as Major, Minor etc. from the academic session 2023-2024. The Syllabus for the purpose will be framed and finalized as per the guidelines of appropriate authority. As an important corollary to the process, the workshop through online mode will be organized on the date mentioned herewith to get the feedback from the stakeholders. Present Students, Alumni, Guardians, Academicians and other stakeholders related to the specific programme/course are requested for their kind participation in the workshop and to present their views/ observations etc. The stakeholders may go through the draft syllabus attached herewith and convey their observations to the office of the undersigned on ugsecretaryoffice@bankurauniv.ac.in within seven days from the date of publication of notice.

Date: Monday, 8th April, 2024

Time: 12:30 PM

Google Meet joining info

Video call link: https://meet.google.com/ggr-veoc-osh

Sd/-
Dr. Arindam Chakraborty
Secretary
Faculty Council for Undergraduate Studies

PROGRAMME AND COURSE STRUCTURE WITH CREDIT DISTRIBUTION

FOR

UG Degree Programmes with Single Major

IN

CHEMISTRY

(*w.e.f.* 2023-2024)

BANKURA UNIVERSITY
BANKURA
WEST BENGAL
PIN - 722155

STRUCTURE IN CHEMISTRY

SEMESTER-I

Category of Course	Course Code	Course Title	Credit	Marks			No. of hours		
				I.A.	ESE	Total	Lec.	Tu.	Lab.
1. Major :: DSC	S/CHEM/101/MJC-1	Fundamentals of Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
2. Minor Stream	S/CHEM/102/MN-1	Fundamentals of Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
3. Multidisciplinary	S/CHEM/103/MD-1	Basic Chemistry	3	10	40	50	45		
4. Skill Enhancement Courses	S/CHEM/104/SEC-1	Basic Analytical Chemistry	3	10	40	50	45		
5. Ability Enhancement Course	ACS/105/AEC-1	Compulsory English: Literature and Communication	2	10	40	50	30		
6. Value Added Courses	ACS/106/VAC-1	Environmental Studies	4	10	40	50	60		
Total credits = 4+4+3+3+2+4 = 20				Total no. of courses = 6					

SEMESTER-II

Category of Course	Course Code	Course Title	Credit	Marks			No. of hours		
				I.A.	ESE	Total	Lec.	Tu.	Lab.
1. Major :: DSC	S/CHEM/201/MJC-2	Fundamentals of Chemistry II	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
2. Minor Stream	S/CHEM/202/MN-2	Fundamentals of Chemistry II	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
3. Multidisciplinary	S/CHEM/203/MD-2	Chemistry in Daily life	3	10	40	50	45		
4. Skill Enhancement Courses	S/CHEM/204/SEC-2	Pharmaceuticals Chemistry	3	10	40	50	45		
5. Ability Enhancement Course	ACS/205/AEC-2	MIL-1 (Santali, Sanskrit and Bengali)	2	10	40	50	30		
6. Value Added Courses	ACS/206/VAC-2	****	4	10	40	50	60		
Total credits = 4+4+3+3+2+4 = 20				Total no. of courses = 6					

**** Health and wellness/Understanding India: Indian Philosophical Traditions and Value Systems/Basics of Indian Constitution/Arts and Crafts of Bengal/Historical Tourism in West Bengal.

SEMESTER-III

Category of Course	Course Code	Course Title	Credit	Marks			No. of hours		
				I.A.	ESE	Total	Lec.	Tu.	Lab.
1. Major :: DSC	S/CHEM/301/MJC-3	Organic Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
2. Major :: DSC	S/CHEM/302/MJC-4	Physical Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
3. Minor Stream	S/CHEM/303/MN-3	Inorganic Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	40	50	45		30
4. Multidisciplinary	S/CHEM/304/MD-3	Analytical Clinical Biochemistry	3	10	40	50	45		
5. Skill Enhancement Courses	S/CHEM/305/SEC-3	Analytical Clinical Biochemistry	3	10	40	50	45		
6. Ability Enhancement Course	ACS/306/AEC-3		2	10	40	50	30		
Total credits = 4+4+4+3+3+2 = 20				Total no. of courses = 6					

SEMESTER-IV

Category of Course	Course Code	Course Title	Credit	Marks			No. of hours		
				I.A.	ESE	Total	Lec.	Tu.	Lab.
1. Major :: DSC	S/CHEM/401/MJC-5	Inorganic Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
2. Major :: DSC	S/CHEM/402/MJC-6	Inorganic Chemistry II	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
3. Major :: DSC	S/CHEM/403/MJC-7	Organic Chemistry II	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
4. Major :: DSC	S/CHEM/404/MJC-8	Physical Chemistry II	3 (Th.) + 1 (Lab.) = 4	10	25 (Th.) 15 (Lab.)	50	45		30
5. Minor Stream	S/CHEM/405/MN-4	Organic Chemistry I	3 (Th.) + 1 (Lab.) = 4	10	40	50	45		30
6. Ability Enhancement Course	ACS/406/AEC-4		2	10	40	50	30		
Total credits = 4+4+4+4+4+2 = 22				Total no. of courses = 6					

N.B.: S = Science, CHEM = Chemistry, MJ = Major, MN = Minor, ACS = Arts Commerce Science, C = Core Course, AEC = Ability Enhancement Course, SEC = Skill Enhancement Course, DSC = Discipline Specific Core, DSE = Discipline Specific Elective, VAC = Value Added Course, MD = Multidisciplinary, I.A. = Internal Assessment, ESE = End-Semester Examination, Lec. = Lecture, Tu.= Tutorial, and Lab. = Laboratory

Important Guidelines

- All graphs for physical chemistry courses must be done using standard spreadsheet software (Excel, Origin etc.)
- Each college should take necessary measures to ensure they should have the following facilities:
  1. UV-VIS Spectrophotometer with printer
  2. Internet facility
  3. Computers (~1 computer for 5 students)
- For proper maintenance of above mentioned facilities, clean & dry AC rooms are mandatory.
- Each lecture is of 1 hr duration for both theory and practical classes.

Bankura University Syllabus for Chemistry 2023-2027

PROGRAMME OUTCOME

The undergraduate (UG) programme of chemistry is composed of major, minor and interdisciplinary subjects. The syllabus is based on the national education policy (NEP) which covers almost all the fields of chemistry. The students will be enriched with plenty of knowledge after the completion of the course. The complete syllabus is compatible with the competitive examination for higher studies and research. In this programme there are various multidisciplinary courses. The students will acquire multidisciplinary skills which will be of tremendous value to them.

SEM-I

Major (MJC - 1)

(Credits - 3 + 1)

Core T-1-Fundamentals of Chemistry I (3 Credits) **(45 Lectures)**

Extra Nuclear Structure of Atom **(8 Lectures)**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory, wave mechanics: de Broglie equation, Heisenberg's uncertainty principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2; quantum numbers and their significance; radial and angular wave functions for hydrogen atom; radial and angular distribution curves; shapes of s, p, d and f orbitals; Pauli's Exclusion Principle, Hund's rules and multiplicity, exchange energy, Aufbau principle and its limitations.

Chemical Periodicity **(6 Lectures)**

Modern IUPAC periodic table, effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction; ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred Rochow's scales); factors influencing these properties, group electronegativities; group trends and periodic trends in these properties in respect of s-, p- and d-block elements; secondary periodicity, relativistic effect, inert pair effect.

Acid Base **(6 Lectures)**

Concepts of acids and bases; thermodynamic acidity parameters, Drago-Wayland equation; superacids, gas phase acidity and proton affinity; HSAB principle; acid-base equilibria in aqueous

solution (proton transfer equilibria in water), pH, buffer; acid-base neutralisation curves; indicator, choice of indicators.

Redox and Precipitation Reactions (10 Lectures)

Elementary idea on standard redox potentials with sign conventions; Nernst equation (without derivation); influence of complex formation, precipitation and change of pH on redox potentials; formal potential; feasibility of a redox titration, redox potential at the equivalence point, redox indicators; redox potential diagram (Latimer and Frost diagrams) of common elements and their applications; disproportionation and comproportionation reactions (typical examples); solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Bonding and Physical Properties of Organic Compounds (10 Lectures)

Introduction: Nomenclature of organic compound, Lewis structure, calculation of formal charges and double bond equivalent (DBE); molecular formula, idea of framing constitution from molecular formula.

Valence bond theory: Concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O systems and s-cis and s-trans geometry for suitable cases).

Electronic displacements: Inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π*, n-MOs; basic idea about frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs; acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems).

Physical properties: Influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.

Stereochemistry-I (5 Lectures)

Bonding geometries of carbon compounds and representation of molecules: Tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.

Concept of chirality and symmetry: Symmetry elements and point groups (C_v, C_{nh}, C_{nv}, C_n, D_h, D_{nh}, D_{nd}, D_n, S_n, C_s, C_i); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudo asymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

Reference Books

- Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
- Douglas, B. E., McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
- Day, M. C., Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
- Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
- Cotton, F. A., Wilkinson, G., Gaus, P. L. Basic Inorganic Chemistry 3rd Ed.; Wiley India.
- Sharpe, A. G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
- Huheey, J. E., Keiter, E. A., Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harpor Collins 1993, Pearson, 2006.
- Dutta, R. L., De, G. S. Inorganic Chemistry (Volume 1); The New Book Stall.
- Sarkar, R. General and Inorganic Chemistry Volume 1, New Central Book Agency (P) Limited.
- Morrison, R. N., Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
- Graham Solomons, T. W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education.
- James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
- Robinson, M. J. T. Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
- Pal, S. C. Principles of Stereochemistry and their Application in Organic Reactions.
- Sen Gupta, S. Basic Stereochemistry of Organic molecules.

Course Outcomes

1. To learn the concept about extra-nuclear structures of atoms.
2. To acquire detailed knowledge about the periodic table and the trend of various periodic properties.
3. To study about acid base reactions in detail.
4. To gather in-depth knowledge about redox and precipitation reactions.

5. To learn detailed knowledge about bonding and physical properties of organic compounds.

6. To gather preliminary and basic knowledge about stereochemistry.

Core P-1-Chemical Analysis Lab (1 Credit) (30 Lectures)

Acid-Base Titrations

1. Standardization of NaOH using standard oxalic acid solution.

2. Estimation of carbonate and bicarbonate present together in a mixture

Oxidation-Reduction Titrimetry

3. Standardization of $KMnO_4$ using standard oxalic acid solution.

4. Estimation of Fe (II) using standardized $KMnO_4$ solution.

5. Estimation of Fe (III) using standard $K_2Cr_2O_7$ solution.

6. Estimation of Fe (II) and Fe (III) in a given mixture using standard $K_2Cr_2O_7$ solution.

Estimation of Organic Compounds

7. Estimation of glucose by titration using Fehling's solution.

8. Estimation of glycine by Sörensen's formol method.

9. Estimation of formaldehyde (Formalin).

10. Estimation of acetic acid in commercial vinegar.

Reference Books

- Mendham, J. A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Mukherjee, G. N. Handbook of Inorganic Analysis, U. N. Dhur Sons Pvt. Ltd, 2014.
- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency (P) Limited 2014.
- Maji, S. K. Practical Inorganic Chemistry, Books and allied (P) Ltd. 2020.
- University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003.
- Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
- Mann, F. G., Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes

1. To become skilled at carrying out acid-base titrations as well as oxidation-reduction analysis after getting hands-on training in laboratory.

2. To become experienced to estimate glucose, glycine, formaldehyde and acetic acid in organic samples.

Minor (MN - 1)

(Credits - 3 + 1)

T-1-Fundamentals of Chemistry I (3 Credits) (45 Lectures)

Extra Nuclear Structure of Atom (8 Lectures)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's theory, wave mechanics: de Broglie equation, Heisenberg's uncertainty principle and its significance, significance of ψ and ψ^2; quantum numbers and their significance; radial and angular wave functions for hydrogen atom; radial and angular distribution curves; shapes of s, p, d and f orbitals; Pauli's exclusion principle, Hund's rules and multiplicity, exchange energy, Aufbau principle and its limitations.

Chemical Periodicity (6 Lectures)

Modern IUPAC Periodic table, effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's, Mulliken's and Allred Rochow's scales) and factors influencing these properties, group electronegativities, group trends and periodic trends in these properties in respect of s-, p- and d-block elements, inert pair effect.

Acid Base (6 Lectures)

Concepts of acids and bases; thermodynamic acidity parameters; Drago-Wayland equation; superacids, gas phase acidity and proton affinity; HSAB principle; acid-base equilibria in aqueous solution (proton transfer equilibria in water), pH, buffer; acid-base neutralisation curves; indicator, choice of indicators.

Redox and Precipitation Reactions (10 Lectures)

Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation), influence of complex formation; precipitation and change of pH on redox potentials; formal potential; feasibility of a redox titration, redox potential at the equivalence point, redox indicators; redox potential diagram (Latimer and Frost diagrams) of common elements and their applications, disproportionation and comproportionation reactions (typical examples); solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Bonding and Physical Properties of Organic Compounds (10 Lectures)

Introduction: Nomenclature of organic compound, Lewis structure, calculation of formal charges and double bond equivalent (DBE); molecular formula, idea of framing constitution from molecular formula.

Valence bond theory: Concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O systems and s-cis and s-trans geometry for suitable cases).

Electronic displacements: Inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π*, n-MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO.

Physical properties: Influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.

Stereochemistry-I (5 Lectures)

Bonding geometries of carbon compounds and representation of molecules: Tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.

Concept of chirality and symmetry: Symmetry elements; molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudo asymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

Reference Books

- Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
- Douglas, B. E., McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
- Day, M. C., Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
- Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
- Cotton, F. A., Wilkinson, G., Gaus, P. L. Basic Inorganic Chemistry 3rd Ed.; Wiley India.

- Sharpe, A. G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
- Huheey, J. E.; Keiter, E. A., Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Atkins, P. W., Paula, J. Physical Chemistry, Oxford Press, 2006.
- Mingos, D. M. P. Essential trends in inorganic chemistry. Oxford University Press (1998).
- Winter, M. J. The Orbitron, http://winter.group.shef.ac.uk/orbitron/(2002). An illustrated gallery of atomic and molecular orbitals.
- Burgess, J. Ions in Solution: Basic Principles of Chemical Interactions. Ellis Horwood (1999).
- Morrison, R. N. Boyd, R. N., Bhattacharjee, S. K. Organic Chemistry, Pearson Education.
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
- Graham Solomons, T. W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Pearson Education.
- James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
- Robinson, M. J. T. Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
- Pal, S. C. Principles of Stereochemistry and their Application in Organic Reactions.
- Sen Gupta, S. Basic Stereochemistry of Organic Molecules.

Course Outcomes

1. To learn the concept about extra-nuclear structures of atoms.
2. To acquire detailed knowledge about the periodic table and the trend of various periodic properties.
3. To study about acid base reactions in detail.
4. To gather in-depth knowledge about redox and precipitation reactions.
5. To learn detail knowledge about bonding and physical properties of organic compounds.
6. To gather preliminary and basic knowledge about stereochemistry.

P-1-Chemical Analysis I (1 Credit) **(30 Lectures)**

Acid-Base Titrations

1. Standardization of NaOH using standard oxalic acid solution.
2. Estimation of carbonate and bicarbonate present together in a mixture.

Oxidation-Reduction Titrimetry

3. Standardization of $KMnO_4$ using standard oxalic acid solution.

4. Estimation of Fe (II) using standardized $KMnO_4$ solution.

5. Estimation of Fe (III) using standard $K_2Cr_2O_7$ solution.

6. Estimation of Fe (II) and Fe (III) in a given mixture using standard $K_2Cr_2O_7$ solution.

Estimation of Organic Compounds

7. Estimation of glucose by titration using Fehling's solution.

8. Estimation of glycine by Sörensen's formol method.

9. Estimation of formaldehyde (Formalin).

10. Estimation of acetic acid in commercial vinegar.

Reference Books

- Mendham, J. A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Mukherjee, G. N. Handbook of Inorganic Analysis, U. N. Dhur Sons Pvt. Ltd, 2014.
- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency (P) Limited 2014.
- Maji, S. K. Practical Inorganic Chemistry, Books and allied (P) Ltd. 2020.
- University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003.
- Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
- Mann, F. G., Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes

1. To become skilled at carrying out acid-base titrations as well as oxidation-reduction analysis after getting hands-on training in laboratory.

2. To become experienced to estimate glucose, glycine, formaldehyde and acetic acid in organic samples.

Multidisciplinary (MD - 1)

(Credits - 3)

Basic Chemistry (3 Credits) **(45 Lectures)**

1. Structure of atom - discovery of sub-atomic particles; atomic models; Bohr's model for hydrogen atom.

2. Classification of element and periodicity in properties - why we need to classify elements? genesis of periodic classification; modern periodic law and the present form of periodic table; periodic trends in properties of elements.

3. Chemistry of carbon compounds: Hybridization of carbon, σ and π bonds, functional group approach for the following (preparations & reactions) to be studied in context to their structures: aliphatic hydrocarbons (alkanes, alkenes, alkynes, alcohols, ethers, carbonyls, carboxylic acids, esters, amines and amide) and aromatic hydrocarbons.

4. Methods of purification of organic compound - filtration, crystallization, sublimation, distillation and chromatography.

5. Acids and bases - different concept of acids and bases - Arrhenius, Lowry-Bronsted, Lewis and salt; ionization of acids and bases, Ostwald dilution law, buffer solution; indicators.

6. Gaseous state, gas laws, ideal gas equation and real gas equation.

7. Thermodynamics - concept of heat and work, state and path function, reversible process, isothermal and adiabatic processes, internal energy, enthalpy, reaction enthalpy.

Reference Book:

- Dutta, R. L., De, G. S. Inorganic Chemistry (Volume I), The New Book Stall.
- Palit, S. R. Elementary Physical Chemistry Book Syndicate Pvt. Ltd.
- Pahari, S. Physical Chemistry New Central Book Agency.
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
- Bahl, A., Bahl, B. S. Advanced Organic Chemistry, S. Chand.
- Sen Gupta, S. Organic Chemistry: General Course, Book Syndicate (P) Ltd.

Course Outcomes

1. To learn the basic chemistry of various types of carbon compounds.
2. To learn different methods for purification of organic compounds.
3. To gather brief knowledge about structure of atoms, elemental periodicity, acids and bases.
4. To acquire basic knowledge about thermodynamics.

Skill Enhancement Course (SEC - 1)

(Credits - 3)

Basic Analytical Chemistry (3 Credits) **(45 Lectures)**

Introduction **(10 Lectures)**

Introduction to analytical chemistry and its interdisciplinary nature; concept of sampling; importance of accuracy, precision and sources of error in analytical measurements; presentation of experimental data and results from the point of view of significant figures.

Analysis of Soil **(6 Lectures)**

Composition of soil, concept of pH and pH measurement, complexometric titrations, chelation, chelating agents, use of indicators

1. Determination of pH of soil samples.

2. Estimation of calcium and magnesium ions as calcium carbonate by complexometric titration.

Analysis of Water **(6 Lectures)**

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods

1. Determination of pH, acidity and alkalinity of a water sample.

2. Determination of dissolved oxygen (DO) of a water sample.

Analysis of Food Products **(6 Lectures)**

Nutritional value of foods, idea about food processing, food preservations and food adulteration

1. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

2. Analysis of preservatives and colouring matter.

Analysis of Cosmetics **(6 Lectures)**

Major and minor constituents and their functions

1. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

2. Determination of constituents of talcum powder: magnesium oxide, calcium oxide, zinc oxide and calcium carbonate by complexometric titration.

Suggested Applications **(6 Lectures)**

1. To study the uses of phenolphthalein in trap cases.

2. To analyse arson accelerants.

3. To carry out analysis of gasoline.

Suggested Instrumental Demonstrations (5 Lectures)

1. Estimation of macro nutrients; potassium, calcium, magnesium in soil samples by flame photometry.
2. Spectrophotometric determination of iron in vitamin/dietary tablets.
3. Spectrophotometric identification and determination of caffeine and benzoic acid in soft drinks.

Reference Books

- Willard, H. H., Merritt, L. L., Dean, J., Settoe, F. A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- Skoog, D. A., Holler, F. J., Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
- Skoog, D. A., West, D. M., Holler, F. J. Analytical Chemistry: An Introduction 6th Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
- Harris, D. C. Quantitative Chemical Analysis, 9th ed. Macmillan Education.
- Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004.
- Day, R. A., Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992.
- Freifelder, D. M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
- Cooper, T. G. The Tools of Biochemistry, John Wiley & Sons, N. Y. USA. 16 (1977).
- Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
- Mendham, J. A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Robinson, J. W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker Inc. New York (1995).
- Christian, G. D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

Course Outcomes:

1. To learn about introduction to analytical chemistry and its interdisciplinary nature.
2. To learn about analysis of soil.
3. To study analysis of water.
4. To gain knowledge of analysis of food products.
5. To come to know about analysis of cosmetics.

SEM II

Major (MJC - 2)

(Credits - 3 + 1)

Core T-2-Fundamentals of Chemistry II (3 Credits) **(45 Lectures)**

Gaseous state I **(12 Lectures)**

1. Kinetic theory of gases: Concept of pressure and temperature; collision of gas molecules; collision diameter; collision number and mean free path; frequency of binary collisions (similar and different molecules); wall collision and rate of effusion.

2. Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; calculations of average, root mean square and most probable values in each case; kinetic energy distribution in one, two and three dimensions, principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Liquid State **(6 Lectures)**

1. Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by Ostwald viscometer method and Stokes falling sphere method; temperature variation of viscosity of liquids and comparison with that of gases.

2. Surface tension: Surface tension, surface energy, excess pressure, capillary rise method, work of cohesion and adhesion, angle of contact; spreading of liquid over other surface; vapour pressure over curved surface; temperature dependence of surface tension.

Thermodynamics I **(12 Lectures)**

1. Zeroth and 1st law of thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; concept of heat, work, internal energy and statement of first law; enthalpy, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions, Joule's experiment and its consequence.

2. Thermochemistry: Standard states; heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; laws of thermochemistry; bond energy, bond

dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; adiabatic flame temperature; explosion temperature.

General treatment of Organic Reaction Mechanism I (10 Lectures)

Mechanistic classification: Ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach.

Reaction thermodynamics: Free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intra-molecular reactions.

Concept of organic acids and bases: Effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophilicity and basicity; HSAB principle; application of thermodynamic principles in acid base equilibria.

Tautomerism: Prototropy (keto-enol, nitro-aci-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria.

Reaction kinetics: Rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (k_H/k_D); principle of microscopic reversibility; Hammond's postulate.

Stereochemistry II (5 Lectures)

Relative and absolute configuration: D/L and R/S descriptors; erythro/threo and meso nomenclature of compounds; syn/anti nomenclatures for aldols; E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- and E/Z-isomerisms.

Optical activity of chiral compounds: Optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

Reference Books

- Atkins, P. W., Paula, J. Atkins' Physical Chemistry, Oxford University Press.
- Castellan, G. W. Physical Chemistry, Narosa.
- McQuarrie, D. A., Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press.
- Engel, T., Reid, P. Physical Chemistry, Pearson
- Levine, I. N. Physical Chemistry, Tata McGraw-Hill.
- Kapoor, K. L. A Textbook of Physical Chemistry, Tata McGraw-Hill.
- Rakshit, P. C. Physical Chemistry, Sarat Book House.
- Ball, D. W. Physical Chemistry, Thomson Press.
- Mortimer, R. G. Physical Chemistry, Elsevier.
- Laidler, K. J. Chemical Kinetics, Pearson.
- Glasstone, S., Lewis, G. N. Elements of Physical Chemistry.
- Zemansky, M. W., Dittman, R. H. Heat and Thermodynamics, Tata-McGraw-Hill.
- Rastogi, R. P., Misra, R. R. An Introduction to Chemical Thermodynamics, Vikas.
- Morrison, R. N., Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T. W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Pearson Education.
- James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
- Robinson, M. J. T. Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
- Pal, S. C. Principles of Stereochemistry and their Application in Organic Reactions.
- Sen Gupta, S. Basic Stereochemistry of Organic molecules.

Course Outcomes

1. To gather detail knowledge about kinetic theory of gases and speed distribution of gas molecules.
2. To acquire in-depth knowledge about viscosity and surface tension of liquid state.
3. To learn detail about thermodynamical parameters and thermochemistry.
4. To learn basic and important points about general organic reaction mechanism.
5. To gather in-depth knowledge about stereochemical configuration and isomerisms.

Core P-2-Physico-Chemical Analysis Laboratory (1 Credit) (30 Lectures)

Physical Chemistry Practicals

1. Determination of relative viscosity of unknown solution (glycerol, sucrose) at various concentrations using Ostwald Viscometer.

2. Determination of surface tension of a liquid at various concentrations using Stalagmometer.

3. Determination of pH of unknown buffer solution by colour matching method.

Identification of Pure Organic Compounds

Solid compounds: Oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid.

Liquid compounds: Formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Determination of melting point and boiling point of identified compounds

Reference Books

- Palit, S. R. Practical Physical Chemistry Science Book Agency.
- Mukherjee, N. G. Selected Experiments in Physical Chemistry J. N. Ghose & Sons.
- Dutta, S. K. Physical Chemistry Experiments Bharati Book Stall.
- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency.
- Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
- Mann, F. G., Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes:

1. To become skilled in order to determine viscosity, surface tension and pH of unknown samples/solutions.

2. To become skilled to identify different kinds of pure organic compounds.

Minor (MN - 2)

(Credits - 3 + 1)

T-2-Fundamental of Chemistry II (3 Credits) (45 Lectures)

Gaseous State I (12 Lectures)

1. Kinetic theory of gases: Concept of pressure and temperature; collision of gas molecules; collision diameter; collision number and mean free path; frequency of binary collisions (similar and different molecules); wall collision and rate of effusion.

2. Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions (derivation not required); expression of average, root mean square and most probable values in each case; kinetic energy distribution in one, two and three dimensions (derivation not required), principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Liquid State (6 Lectures)

1. Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by Ostwald viscometer method and Stokes falling sphere method; temperature variation of viscosity of liquids and comparison with that of gases.

2. Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; work of cohesion and adhesion, angle of contact; spreading of liquid over other surface, vapour pressure over curved surface; temperature dependence of surface tension.

Thermodynamics I (12 Lectures)

1. Zeroth and 1st law of thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; concept of heat, work, internal energy and statement of first law; enthalpy, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions, Joule's experiment and its consequence.

2. Thermo-chemistry: Standard states; heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; laws of thermo-chemistry; bond energy, bond dissociation energy and resonance energy from thermo-chemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; adiabatic flame temperature; explosion temperature.

General treatment of Organic Reaction Mechanism I (10 Lectures)

Mechanistic classification: Ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach.

Reaction thermodynamics: Free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intra-molecular reactions.

Concept of organic acids and bases: Effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophilicity and basicity; HSAB principle; application of thermodynamic principles in acid base equilibria.

Tautomerism: Prototropy (keto-enol, nitro-aci-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria.

Reaction kinetics: Rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (k_H/k_D); principle of microscopic reversibility; Hammond's postulate.

Stereochemistry-II (5 Lectures)

Relative and absolute configuration: D/L and R/S descriptors; erythro/threo and meso nomenclature of compounds; syn/anti nomenclatures for aldols; E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- and E/Z- isomerisms.

Optical activity of chiral compounds: Optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

Reference Books

- Barrow, G. M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J. C., Treichel, P. M., Townsend, J. R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B. H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R. H. General Chemistry 5th Ed. Macmillan Publishing Co. New York (1985).
- Chugh, K. L., Agnish, S. L. A Text Book of Physical Chemistry Kalyani Publishers.
- Bahl, B. S., Bahl, A., Tuli, G. D. Essentials of Physical Chemistry S. Chand & Co. Ltd.
- Palit, S. R. Elementary Physical Chemistry Book Syndicate Pvt. Ltd.
- Mandal, A. K. Degree Physical and General Chemistry Sarat Book House.
- Pahari, S. Physical Chemistry New Central Book Agency
- Pahari, S., Pahari, D. Problems in Physical Chemistry New Central Book Agency
- Shriver, D. F., Atkins, P. W. Inorganic Chemistry, Oxford University Press.
- Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
- Rodgers, G. E. Inorganic Solid State Chemistry, Cengage Learning India Ltd., 2008.
- Morrison, R. N., Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T. W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education.
- James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
- Robinson, M. J. T. Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
- Pal, S. C. Principles of Stereochemistry and their Application in Organic Reactions.
- Sen Gupta, S. Basic Stereochemistry of Organic molecules.

Course Outcomes

1. To gather detail knowledge about kinetic theory of gases and speed distribution of gas molecules.
2. To acquire in-depth knowledge about viscosity and surface tension of liquid state.
3. To learn detail about thermodynamical parameters and thermochemistry.

4. To learn basic and important points about general organic reaction mechanism.

5. To gather in-depth knowledge about stereochemical configuration and isomerisms.

P-2-Physico-Chemical Analysis Laboratory (1 Credit) (30 Lectures)

Physical Chemistry Practicals

1. Determination of relative viscosity of unknown solution (glycerol, sucrose) using Ostwald Viscometer.

2. Determination of surface tension of a liquid using Stalagmometer.

3. Determination of pH of unknown buffer solution by colour matching method.

Identification of Pure Organic Compounds

Solid compounds: Oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid.

Liquid Compounds: Formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Determination of melting point and boiling point of identified compounds

Reference Books

- Palit, S. R. Practical Physical Chemistry Science Book Agency.
- Mukherjee, N. G. Selected Experiments in Physical Chemistry J. N. Ghose & Sons.
- Dutta, S. K. Physical Chemistry Experiments Bharati Book Stall.
- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency.
- Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
- Mann, F.G., Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes

1. To become skilled in order to determine viscosity, surface tension and pH of unknown samples/solutions.

2. To become skilled to identify different kinds of pure organic compounds.

Multidisciplinary (MD - 2)

(Credits - 3)

Chemistry in Daily Life (3 Credits) **(45 Lectures)**

1. Hydrocarbons in daily use: Coal based chemicals, petro-chemicals-kerosene, Liquefied petroleum gas (LPG).

2. Agrochemicals: Manufacture of ammonia and ammonium salts, sulphur-phosphate, fungicides, herbicides, pesticides.

3. Glass and ceramics: Manufactures of glasses, optical glass and colour glass, porcelain, enamel and cement.

4. Food chemistry: Classification of foods - carbohydrates, proteins and fats; nutritional and medicinal values, food additives-food flavour, food colour, food preservatives, artificial sweeteners, food adulteration in some common foods like turmeric, coriander, peppers etc.

5. Drugs and pharmaceuticals: Aspirin, paracetamol, ibuprofen, vitamin C, vitamin B12 etc.

6. Surface chemistry: Surface tension of liquids and related phenomenon, colloids and surface active agents (detergents), micelles and applications.

Reference Books

- Mandal, S. K., Ghanta, R. Pharmaceutical Chemistry and Production: An Introductory Textbook. Bentham Science Publishers 2022, ISBN: 978-1-68108-890-7.
- Sengupta, S. Application Oriented Chemistry. Books Syndicate Pvt. Ltd., 2000.
- Gangopadhyay, P. K. Application Oriented Chemistry. Books Syndicate Pvt. Ltd.

Course Outcomes

1. To learn about daily usable hydrocarbons, agrochemicals, glass and ceramics.
2. To gather basic knowledge about food chemistry, drugs and pharmaceuticals and surface chemistry.

Skill Enhancement Course (SEC - 2)

(Credits - 3)

Pharmaceuticals Chemistry (3 Credits) **(45 Lectures)**

Drugs & Pharmaceuticals

Drug discovery, design and development; basic retro-synthetic approach, synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal

agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), central nervous system agents (Phenobarbital, Diazepam), cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation, production of (i) ethyl alcohol and citric acid, (ii) antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Hands on Practical

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bi-silicate (antacid).

Reference Books

- Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
- Singh, H., Kapoor, V. K. Medicinal and Pharmaceutical Chemistry, VallabhPrakashan, Pitampura, New Delhi, 2012.
- Foye, W. O., Lemke, T. L., William, D. A. Principles of Medicinal Chemistry, 4th ed., B. I. Waverly Pvt. Ltd. New Delhi.
- Pharmaceutical Chemistry and Production: An Introductory Textbook by Samir Kumar Mandal, Rebeca Ghanta; Bentham Science Publishers 2022, ISBN: 978-1-68108-890-7.

Course Outcomes

1. To learn about drugs and pharmaceuticals in detail.
2. To gather basic knowledge about fermentation process.
3. To know the hands on preparation procedure of Aspirin and magnesium bi-silicate.

SEM-III

Major (MJC - 3)

(Credits - 3 + 1)

Core T-3-Organic Chemistry I (3 Credits) **(45 Lectures)**

MO Theory **(5 Lectures)**

Cyclic p-orbital system (neutral systems):[4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity upto [10]-annulene (including mono nuclear heterocyclic compounds upto 6-membered ring); concept of anti-aromaticity and homo-aromaticity; non-aromatic molecules; Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.

General Treatment of Reaction Mechanism I **(25 Lectures)**

Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, and carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behaviour of reactive intermediates (elementary idea).

Substitution and elimination reactions: free-radical substitution reactions: halogenation of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate.

Nucleophilic substitution reactions: substitution at sp^3 centre: mechanisms (with evidence), relative rates and stereochemical features: S_N1, S_N2, S_N2', $SN^{1'}$ (allylic rearrangement) and S_N^i, effects of solvent, substrate structure, leaving group and nucleophiles (including ambient nucleophiles, cyanide and nitrite); substitutions involving NGP; role of crown ethers and phase transfer catalysts.

Elimination reactions: E1, E2, E1CB and Ei (pyrolytic *syn*-eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination; importance of Bredt's rule relating to the formation of C=C.

Electrophilic aromatic substitution: mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); *Ipso*-substitution.

Nucleophilic aromatic substitution: addition-elimination mechanism and evidences in favour of it; aromatic S_N^1 mechanism; *cine* substitution (benzyne mechanism), structure of benzyne.

Stereochemistry II **(15 Lectures)**

Chirality arising out of stereo-axis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidene cycloalkanes and biphenyls; related configurational descriptors (Ra/Sa and P/M); atropisomerism; racemisation of chiral biphenyls; buttressing effect.

Concept of prostereoisomerism: pro-stereogenic centre; concept of (pro) n-chirality: topicity of ligands and faces (elementary idea); pro-R/pro-S, pro-E/pro-Z and Re/Si descriptors; pro-r and pro-s descriptors of ligands on propseudoasymmetric centre.

Conformation: conformational nomenclature: eclipsed, staggered, gauche, *syn* and *anti*; dihedral angle, torsion angle; Klyne-Prelog terminology; P/M descriptors; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; butane gauche interaction; conformational analysis of ethane, propane, n-butane, 2-methyl butane and 2,3-diSmethyl butane; haloalkanes, 1,2-dihaloalkanes and 1,2-diols (upto four carbons); 1,2-halohydrins; conformation of conjugated systems (s-cis and s-trans).

Reference Books

- Finar, I. L. Organic Chemistry (Volume 1), 6th Ed. Pearson Education India.
- Morrison, R. T., Boyd, R. N., Bhattacharjee, S. K. Organic Chemistry, Pearson Education.
- Solomons, G. T. W., Fryhle, C. B., Snyder, S. A. Organic Chemistry, 4th Ed. 2016, John Wiley & Sons, Inc.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Pearson Education.
- March, J. Advanced Organic Chemistry, 4th Ed., Wiley.
- Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Oxford University Press.
- Eliel, E. L., Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
- Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
- Pal, S. C. Principles of Stereochemistry and their Application in Organic Reactions.
- Sen Gupta, S. Basic Stereochemistry of Organic Molecules.

Course Outcomes

1. To impart understanding of the MO theory on cyclic p orbital system and the concept about aromaticity.

2. To develop detailed understanding of organic reaction mechanism, types of organic reactions.
3. To acquire the essence of stereochemistry of organic molecules, which include chirality arising out of stereo-axis, concept of prostereoisomerism and conformation.
4. To gather knowledge and skills to understand the laboratory methods related to organic preparation, separation of the binary organic mixture and the determination of boiling point of different organic samples.
5. To gather knowledge and skills to understand the laboratory methods and tests related to detection of elements and functional groups in different organic samples.

Core P-3-Organic Chemistry I Laboratory (1 Credit) (30 Lectures)

PART A

1. Organic preparations: The following reactions are to be performed, noting the yield of the crude product:

i. Nitration of aromatic compounds
ii. Condensation reactions
iii. Hydrolysis of amides/imides/esters
iv. Acetylation of phenols/aromatic amines
v. Benzoylation of phenols/aromatic amines

Students must also calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

2. Purification of the crude product is to be made by crystallization from water/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.
3. Melting point of the purified product is to be noted.

PART B

1. Separation of binary mixture: based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, etc., of components of a binary solid mixture; purification of any one of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: benzoic acid and *p*-toluidine; *p*-nitrobenzoic acid and *p*-aminobenzoic acid; *p*-nitrotolune and *p*-anisidine; benzoic acid and benzophenone, urea and benzophenone etc.

2. Determination of boiling point: determination of boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, chloroform, ethyl methyl ketone, cyclohexanone,

acetylacetone, anisole, crotonaldehyde, mesityl oxide etc. [Boiling point of the chosen organic compounds should preferably be less than 160°C and higher than 60 °C].

Reference Books

- Vogel, A. I. Elementary Practical Organic Chemistry, Part 1: Small Scale Preparations, CBS Publishers and Distributors.
- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency.
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes

1. To gather knowledge and skills to understand the laboratory methods related to organic preparation.
2. To develop practical knowledge about separation of the binary organic mixture.
3. To determine the boiling points of different organic liquid compounds.

Major (MJC - 4)

(Credits - 3 + 1)

Core T-4-Physical Chemistry I (3 Credits) **(45 Lectures)**

Gaseous State II **(9 Lectures)**

Real Gas and Intermolecular forces: deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behavior; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions); Lennard-Jones potential - elementary idea.

Thermodynamics II **(15 Lectures)**

1. Second Law: need for a second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine and refrigerator; Kelvin-Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of dQ/T and Clausius inequality; Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work;

Auxiliary state functions (G and A) and their variation with T, P and V, criteria for spontaneity and equilibrium.

2. Thermodynamic relations: Maxwell's relations; Gibbs-Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; general heat capacity relations.

Chemical Equilibrium (6 Lectures)

Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); variation of free energy with degree of advancement; equilibrium constant and standard Gibbs free energy change; definitions of K_P, K_C and K_X; van't Hoff's reaction isobar and isochore from different standard states; shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation.

Chemical Kinetics I (15 Lectures)

Rate law, order and molecularity: introduction of rate law, extent of reaction; rate constants, order; rate equation for of first, second and nth order reactions; pseudo first order reactions; determination of order of a reaction by half-life and differential method; opposing reactions, consecutive reactions and parallel reactions (all steps first order); kinetic and thermodynamic control of products.

Role of temperature and theories of reaction rate: temperature dependence of rate constant; Arrhenius equation, energy of activation; rate-determining step and steady-state approximation - explanation with suitable examples; collision theory; Lindemann theory of unimolecular reaction; outline of transition state theory (classical treatment).

Reference Books

- Atkins, P. W., Paula, J. de Atkins' Physical Chemistry, Oxford University Press.
- Castellan, G. W. Physical Chemistry, Narosa.
- McQuarrie, D. A., Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press.
- Engel, T., Reid, P. Physical Chemistry, Pearson.
- Levine, I. N. Physical Chemistry, Tata McGraw-Hill.
- Glasstone, S., Lewis, G. N. Elements of Physical Chemistry.
- Zemansky, M. W., Dittman, R. H. Heat and Thermodynamics, Tata-McGraw-Hill.
- Rastogi, R. P., Misra, R. R. An Introduction to Chemical Thermodynamics, Vikas.
- Ball, D. W. Physical Chemistry, Thomson Press.

- Mortimer, R. G. Physical Chemistry, Elsevier.
- Laidler, K. J. Chemical Kinetics, Pearson.
- Kapoor, K. L. A Textbook of Physical Chemistry, Tata McGraw-Hill.
- Rakshit, P. C. Physical Chemistry, Sarat Book House.

Course Outcomes

1. To learn about the basic properties of real gases and weak intermolecular forces.
2. To acquire knowledge about 2nd law of thermodynamics and important thermodynamic relations.
3. To gather in-depth knowledge about chemical equilibrium.
6. To gather preliminary and basic knowledge about reaction kinetics.

Core P-3-Physical Chemistry I Laboratory (1 Credit) **(30 Lectures)**

1. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate.
2. Study of kinetics of decomposition of H_2O_2.
3. Study of kinetics of $K_2S_2O_8$ + KI reaction.

Reference Books

- Viswanathan, B., Raghavan, P. S. Practical Physical Chemistry, Viva Books, 2009.
- Mendham, J. A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson.
- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman, 2007.
- Palit, S. R., De, S. K. Practical Physical Chemistry Science Book Agency.
- University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta.
- Levitt, B. P. edited Findlay's Practical Physical Chemistry, Longman Group Ltd.
- Gurtu, J. N., Kapoor, R. Advanced Experimental Chemistry, S. Chand & Co. Ltd.

Course Outcomes

1. To become skilled at carrying out acid catalyzed hydrolysis of ester.
2. To become experienced to monitor the kinetics of any chemical reaction.

Minor (MN - 3)

(Credits - 3 + 1)

T-3-Inorganic Chemistry I (3 Credits) **(45 Lectures)**

Chemical Bonding and Molecular Structure **(30 Lectures)**

Ionic bonding: general characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds; statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability; Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB approach: shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds;

MO approach: rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Comparative Study of p-block Elements (15 Lectures)

Group trends in electronic configuration, modification of pure elements, common oxidation states, inertpair effect, and their important compounds in respect of the following groups of elements:

i. B-Al-Ga-In-Tl
ii. C-Si-Ge-Sn-Pb
iii. N-P-As-Sb-Bi
iv. O-S-Se-Te
v. F-Cl-Br-I

Reference Books

- Huheey, J. E., Keiter, E. A., Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed. Harper Collins 1993, Pearson, 2006.
- Greenwood, N. N., Earnshaw, A. Chemistry of the Elements, Butterworth-Heinemann, 1997.
- Cotton, F. A., Wilkinson, G., Murrillo, C. A., Bochmann, M. Advanced Inorganic Chemistry 6th Ed. 1999, Wiley.
- Miessler, G. L., Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
- Purecell, K. F., Kotz, J. C. An Introduction to Inorganic Chemistry, Saunders:Philadelphia, 1980.
- Mingos, D. M. P. Essential Trends in Inorganic Chemistry, Oxford University Press, 1998.

Course Outcomes

1. To acquire detailed knowledge about ionic and covalent bonding among atoms.
2. To learn the basic concept of chemical bonding with the help of MO theory.
3. To learn the comparative study of p-block elements.

P-3-Inorganic Chemistry I Laboratory (1 Credit) **(30 Lectures)**

Qualitative semi-micro analysis of mixtures containing three radicals; emphasis should be given to theunderstanding of the chemistry of different reactions.

Acid Radicals: Cl^-, Br^-, I^-, NO_2^-, NO_3^-, S^{2-}, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, H_3BO_3.

Basic Radicals: Na^+, K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Cr^{3+}, Mn^{2+}, Fe^{3+}, Ni^{2+}, Cu^{2+}, NH_4^+.

Reference Books

- Svehla & Sivasankar, Vogel's Qualitative Inorganic Analysis, 7th Ed. Pearson, 2012.
- Maji, S. K. Practical Inorganic Chemistry Books & Allied (P) Ltd.

Course Outcomes

1. To become skilled at carrying out qualitative semi-micro analysis of mixtures of three radicals.

Multidisciplinary (MD - 3)

(Credits - 3)

Analytical Clinical Biochemistry (3 Credits) **(45 Lectures)**

Review of Concepts from Core Course **(15 Lectures)**

1. Carbohydrates: biological importance of carbohydrates

2. Proteins: classification, biological importance; primary and secondary and tertiary structures of proteins, denaturation of proteins.

3. Enzymes: classification; active site, coenzymes and cofactors, biocatalysis, effect of pH and temperature on enzyme activity.

4. Lipids: biological importance of triglycerides and phosphoglycerides and cholesterol.

5. Structure of DNA (Watson-Crick Model) and RNA, genetic code, biological roles of DNA and RNA.

Biochemistry of Disease **(10 Lectures)**

A diagnostic approach of blood/ urine analysis:

1. Blood: composition and functions of blood, blood coagulation; blood collection and preservation of samples; anaemia, regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

2. Urine: collection and preservation of samples; formation of urine; composition and estimation of constituents of normal and pathological urine.

Hands on Practical **(20 Lectures)**

PART A:

Identification and estimation of the following:

1. Carbohydrates - qualitative and quantitative.
2. Lipids - qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Proteins - qualitative.

Reference Books

- Cooper, T. G. Tool of Biochemistry. Wiley-Blackwell.
- Wilson, K., Walker, J. Practical Biochemistry, Cambridge University Press.
- Varley, H., Gowenlock, A. H., Bell, M. Practical Clinical Biochemistry, Heinemann, London.
- Devlin, T. M. Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons.
- Berg, J. M., Tymoczko, J. L., Stryer, L. Biochemistry, W.H. Freeman.
- Talwar, G. P., Srivastava, M. Textbook of Biochemistry and Human Biology, PHI Learning.
- Nelson, D. L., Cox, M. M. Lehninger Principles of Biochemistry, W.H. Freeman.
- Mikes, O., Chalmers, R. A. Laboratory Handbook of Chromatographic Methods, D. Van Nostrand & Co.
- Basu, K., Saha, C., Chakraborty, B., Chakraborty, S. Lectures on Analytical Clinical Biochemistry, Techno World.

Course Outcomes

1. To learn the basic concept of carbohydrates, protein, enzymes, lipids etc.
2. To acquire knowledge about the diagnostic approach of blood and urine analysis.
3. To gather hands on laboratory experience about estimation of carbohydrates, lipids and proteins.

Skill Enhancement Course (SEC - 3)

(Credits - 3)

Analytical Clinical Biochemistry (3 Credits) **(45 Lectures)**

Review of Concepts from Core Course **(15 Lectures)**

1. Carbohydrates: biological importance of carbohydrates, metabolism, cellular currency of energy (ATP), glycolysis, alcoholic and lactic acid fermentations, Krebs cycle; isolation and characterization of polysachharides.

2. Proteins: classification, biological importance; primary and secondary and tertiary structures of proteins: α-helix and β-pleated sheets, isolation, characterization, denaturation of proteins.

3. Enzymes: nomenclature, characteristics (mention of ribozymes), and classification; active site, mechanism of enzyme action, stereospecificity of enzymes, coenzymes and cofactors, enzyme inhibitors, introduction to biocatalysis: importance in "green chemistry" and chemical industry.

4. Lipids: classification. biological importance of triglycerides and phosphoglycerides and cholesterol; lipid membrane, liposomes and their biological functions and underlying applications; lipoproteins; properties, functions and biochemical functions of steroid hormones; biochemistry of peptide hormones.

5. Structure of DNA (Watson-Crick Model) and RNA, genetic code, biological roles of DNA and RNA: replication, transcription and translation, introduction to gene therapy.

6. Enzymes: nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of Disease **(10 Lectures)**

A diagnostic approach of blood/ urine analysis:

1. Blood: composition and functions of blood, blood coagulation; blood collection and preservation of samples; anaemia, regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

2. Urine: collection and preservation of samples; formation of urine; composition and estimation of constituents of normal and pathological urine.

Hands on Practical **(20 Lectures)**

PART A:

Identification and estimation of the following:

1. Carbohydrates - qualitative and quantitative.
2. Lipids - qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann-Burchard reaction.
6. Proteins - qualitative.

7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids.

PART B:

Data Handling

1. Introductory report writing activities: creating word document file and incorporation of text (MS-word); incorporation of chemical structures, chemical equations (use of ChemSketch and ChemDraw software).

2. Handling numeric data: creating a spreadsheet (MS-Excel), entering and formatting information, basic functions and formulae, creating charts, tables and graphs; incorporating tables and graphs into word processing documents; simple calculations, plotting graphs using a spreadsheet; presentation: presentation of information in powerpoint document (MS-powerpoint).

Reference Books

- Cooper, T. G. Tool of Biochemistry. Wiley-Blackwell.
- Wilson, K., Walker, J. Practical Biochemistry, Cambridge University Press.
- Varley, H., Gowenlock, A. H., Bell, M. Practical Clinical Biochemistry, Heinemann, London.
- Devlin, T. M. Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons.
- Berg, J. M., Tymoczko, J. L., Stryer, L. Biochemistry, W.H. Freeman.
- Talwar, G. P., Srivastava, M. Textbook of Biochemistry and Human Biology, PHI Learning.
- Nelson, D. L., Cox, M. M. Lehninger Principles of Biochemistry, W.H. Freeman.
- Mikes, O., Chalmers, R. A. Laboratory Handbook of Chromatographic Methods, D. Van Nostrand & Co.
- Basu, K., Saha, C., Chakraborty, B., Chakraborty, S. Lectures on Analytical Clinical Biochemistry, Techno World.

Course Outcomes

1. To learn the basic concept of carbohydrates, protein, enzymes, lipids etc.
2. To acquire knowledge about the diagnostic approach of blood and urine analysis.
3. To gather hands on laboratory experience about estimation of carbohydrates, lipids and proteins.
4. To acquire hands on experience on isolation of protein, determination of cholesterol and nucleic acids etc.
5. To develop basic knowledge about data handling using MS Word, MS Excel and MS PowerPoint.

SEM IV

Major (MJC - 5)

(Credits - 3 + 1)

Core T-5-Inorganic Chemistry I (3 Credits) (45 Lectures)

Chemical Bonding, Theoretical Principles of Inorganic Qualitative Analysis (35 Lectures)

Ionic bond: general characteristics, types of ions, size effects, radius ratio rule, application and limitations; packing of ions in crystals; Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy; Madelung constant, Born-Haber cycle and its application, solvation energy; defects in solids (elemementary idea); solubility energetics of dissolution process.

Covalent bond: polarizing power and polarizability, ionic potential, Fazan's rules, Lewis structures, formal charge; valence bond theory; the hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main group chemistry) and multiple bonding (σ and π bond approach).

Molecular orbital concept of bonding: (the approximations of the theory, linear combination of atomic orbitals (LCAO)) (elementary pictorial approach) sigma, pi-bonds, delta interaction, multiple bonding; orbital designations: gerade, ungerade, HOMO, LUMO, orbital mixing; MO diagrams of H_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO^+, CN^-, HF, BeH_2, CO_2 and H_2O; bond properties: bond orders, bond lengths.

Metallic bond: qualitative idea of valence bond and band theories; semiconductors and insulators, defects in solids.

Weak chemical forces: Van der waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions, repulsive forces, intermolecular forces: hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, halogen bonds; effects of chemical force, melting and boiling points.

Theoretical Principles of Inorganic Qualitative Analysis (10 Lectures)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect, principle involved in separation of cations into groups and choice of group reagents, interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

Reference Books

- Lee, J. D. Concise Inorganic Chemistry 5th Ed., John Wiley and Sons 2008.
- Huheey, J. E.; Keiter, E.A., Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Douglas, B. E., McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
- Porterfield, H. W. Inorganic Chemistry, 2nd Ed. Academic Press, 2005.
- Purecell, K. F., Kotz, J. C. An Introduction to Inorganic Chemistry, Saunders:Philadelphia, 1980.
- Cotton, F.A., Wilkinson, G., Gaus, P. L. Basic Inorganic Chemistry 3rd Ed.; Wiley India.
- Gillespie, R. J., Hargittai, I. The VSEPR Model of Molecular Geometry, Prentice Hall, 1992.
- Albright, T. Orbital Interactions in Chemistry, John Wiley and Sons, 2005.
- Mingos, D. M. P. Essential Trends in Inorganic Chemistry, Oxford University Press, 1998.
- Miessler, G. L., Fischer, P. J., Tarr, D. A. Inorganic Chemistry, Pearson, 5th Edition.

Course Outcomes

1. To acquire detailed knowledge about ionic and covalent bonding among atoms.
2. To learn the detail of molecular orbital concept of chemical bonding.
3. To learn about properties of metallic bond and weak chemical forces.
4. To gather knowledge about theoretical principles of inorganic qualitative analysis.

Core P-5-Inorganic Chemistry I Lab (1 Credit) **(30 Lectures)**

Qualitative semi-micro analysis of mixtures containing three radicals; Emphasis should be given to the understanding of the chemistry of different reactions:

Cation Radicals: Na^+, K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}/Mn^{4+}, Fe^{3+}, Co^{2+}/Co^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}/Sn^{4+}, $Sb^{3+/5+}$, NH_4^+, Mg^{2+}.

Anion Radicals: F^-, Cl^-, Br^-, BrO_3^-, I^-, IO_3^-, SCN^-, S^{2-}, SO_4^{2-}, NO_3^-, NO_2^-, PO_4^{3-}, H_3BO_3, BO_3^{3-}, $CrO_4^{2-}/Cr_2O_7^{2-}$, $Fe(CN)_6^{4-}$, $Fe(CN)_6^{3-}$.

Insoluble Materials: Al_2O_3 (ig), Fe_2O_3 (ig), Cr_2O_3 (ig), SnO_2, $SrSO_4$, $BaSO_4$, CaF_2, $PbSO_4$.

Reference Books:

- Svehla & Sivasankar, Vogel's Qualitative Inorganic Analysis, 7th Ed. Pearson, 2012.
- Maji, S. K. Practical Inorganic Chemistry Books & Allied (P) Ltd.

Course Outcomes

1. To become skilled at carrying out qualitative semi-micro analysis of mixtures of three radicals.

Major (MJC - 6)

(Credits - 3 + 1)

Core T-6-Inorganic Chemistry II (3 Credits) **(45 Lectures)**

Chemistry of s and p Block Elements **(15 Lectures)**

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group, allotropy and catenation; study of the following compounds with emphasis on structure, bonding, preparation, properties and uses: beryllium hydrides and halides, boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine, peroxo acids of sulphur, sulphur-nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens.

Noble Gases **(10 Lectures)**

Occurrence and uses, rationalization of inertness of noble gases, clathrates: preparation and properties of XeF_2, XeF_4 and XeF_6; nature of bonding in noble gas compounds (valence bond treatment and MO treatment for XeF_2 and XeF_4); xenon-oxygen compounds, molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers **(8 Lectures)**

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes, borazines, silicates and phosphazenes

Coordination Chemistry-I **(12 Lectures)**

Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centres), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

Reference Books

- Huheey, J. E., Keiter, E. A., Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed. Harper Collins 1993, Pearson, 2006.
- Greenwood, N. N., Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997.
- Cotton, F. A., Wilkinson, G., Murrillo, C. A., Bochmann, M. Advanced Inorganic Chemistry 6th Ed. Wiley, 1999.

- Miessler, G. L., Donald, A. Tarr. Inorganic Chemistry, 4th Ed., Pearson, 2010.
- Purecell, K.F., Kotz, J. C. An Introduction to Inorganic Chemistry, Saunders:Philadelphia, 1980.
- Mingos, D. M. P. Essential Trends in Inorganic Chemistry, Oxford University Press, 1998.

Course Outcomes

1. To acquire detailed knowledge about the chemistry of s and p block elements.
2. To study about the basic characteristics of noble gas.
3. To gather knowledge about inorganic polymers.
4. To learn preliminary knowledge about co-ordination chemistry.

Core P-6-Inorganic Chemistry II Laboratory (1 Credit) (30 Lectures)

Iodo/Iodimetric Titrations

- Estimation of Cu(II)
- Estimation of Vitamin C.
- Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically.
- Estimation of available chlorine in bleaching powder.

Estimation of metal content in some selective samples

- Estimation of Cu in brass.
- Estimation of Fe in cement.

Reference Books

- Mendham, J. A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Course Outcomes

1. To become experienced to estimate vitamin C, chlorine, copper etc. in a given sample.
2. To become skilled to evaluate the metal content in brass and cement.

Major (MJC - 7)

(Credits - 3 + 1)

Core T-7-Organic Chemistry II (3 Credits) (45 Lectures)

Chemistry of Alkenes and Alkynes (15 Lectures)

Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and *anti*-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenations, iodolactonisation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation ,*syn*- and *anti*-hydroxylation, ozonolysis, addition of singlet and

triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of *E*- and *Z*-alkenes; contra-thermodynamic isomerization of internal alkenes.

Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity (Markownikoff and *anti*-Markownikoff addition) and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and nonterminal alkynes.

Carbonyl and related Compounds (30 Lectures)

Addition to C=O: structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions; formation of hydrates, cyanohydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen-based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupere arrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols.

Exploitation of acidity of α-H of C=O: formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H.V.Z.) reaction, nitrosation, SeO_2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines, aza-enolates and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

Nucleophilic addition to α, β-unsaturated carbonyl system: general principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulation.

Substitution at Sp^2 carbon (C=O system): mechanism (with evidence): BAC2, AAC2, AAC1, AAL1 (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

Reference Books

- Finar, I. L. Organic Chemistry (Volume 1), 6th Ed, Pearson Education India.
- Morrison, R. T., Boyd, R. N., Bhattacharjee, S. K. Organic Chemistry, Pearson Education.
- Solomons, T. W. G., Fryhle, C. B., Snyder, S. A. Organic Chemistry, 4th Ed, 2016, John Wiley & Sons, Inc.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Pearson Education.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
- Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Oxford University Press.
- Loudon, G. M. Organic Chemistry, 4th Ed, Oxford University Press.
- Carey, F. A., Guiliano, R. M. Organic Chemistry, 8th Ed, McGraw Hill Education.

Course Outcomes

1. To understand the chemistry of alkenes and alkynes: reactions, mechanisms and structure.
2. To understand the chemistry of carbonyl and related Compounds; reactions, mechanisms and structure.

Core P-7-Organic Chemistry II Laboratory (1 Credit) (30 Lectures)

Qualitative Analysis of Single Solid Organic Compounds

1. Detection of special elements (N, S, Cl, Br) by Lassaigne's test.
2. Solubility and classification (solvents: H_2O, 5 % HCl, 5 % NaOH and 5 % $NaHCO_3$).
3. Detection of the following functional groups by systematic chemical tests: aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), phenolic-OH, carboxylic acid (-COOH), carbonyl (-CHO and >C=O); only one test for each functional group is to be reported.
4. Melting point of the given compound.
5. Preparation, purification and melting point determination of a crystalline derivative of the given compound.
6. Identification of the compound through literature survey. Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation in known and unknown (at least six) organic compounds.

Reference Books

- Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.

- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency.
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes

1. To gather knowledge and skills to understand the laboratory methods and tests related to detection of elements and functional groups in different organic samples.
2. To gather knowledge and skills to understand the laboratory methods for further functionalization of exiting functional groups in different organic samples.

Major (MJC - 8)

(Credits - 3 + 1)

Core T-8-Physical Chemistry II (3 Credits) **(45 Lectures)**

Application of Thermodynamics **(25 Lectures)**

Partial properties and chemical potential: chemical potential and activity, partial molar quantities; variation of chemical potential (μ) with temperature and pressure; Gibbs-Duhem equation; fugacity and fugacity coefficient; variation of thermodynamic functions for systems with variable composition; change in G, S H and V during mixing for binary solutions; first order phase transition and Clapeyron equation; Clausius-Clapeyron equation-derivation and use.

Chemical potential and other properties of ideal substances: pure and mixtures: a) pure ideal gas-its chemical potential; thermodynamic parameters of mixing; chemical potential of an ideal gas in an ideal gas mixture; concept of standard states and choice of standard states of ideal gases b) condensed phase - chemical potential of pure solid and pure liquids, ideal solution - definition, Raoult's law and Henry's law; mixing properties of ideal solutions, chemical potential of a component in an ideal solution; choice of standard states of solids and liquids.

Nernst's distribution law: application - (finding out K_{eq} using Nernst distribution law for $KI + I_2 = KI_3$, dimerization of benzene and solvent extraction.

Colligative properties: vapour pressure of solution; ideal solutions, ideally diluted solutions and colligative properties; thermodynamic derivation using chemical potential to derive relations between the four colligative properties - relative lowering of vapour pressure, elevation of boiling point, depression of freezing point and osmotic pressure and amount of solute; applications in calculating

molar masses of normal, dissociated and associated solutes in solution; abnormal colligative properties.

Phase rule: definitions of phases, components and degrees of freedom; phase rule and its derivations; definition of phase diagram; phase diagram for water, CO_2, sulphur; phenol-water system; binary solutions: ideal solution at fixed temperature and pressure; liquid vapour equilibrium for two component systems; principle of fractional distillation; Duhem-Margules equation; Konowaloff's rule; positive and negative deviations from ideal behavior; azeotropic solution; solid-liquid phase diagram; eutectic mixture.

Ionic Conductance **(12 Lectures)**

Ion conductance; conductance and measurement of conductance, cell constant, specific conductance and molar conductance; variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Debye-Huckel theory of ion atmosphere (qualitative)-asymmetric effect, relaxation effect and electrophoretic effect; Ostwald's dilution law; ionic mobility; application of conductance measurement (determination of solubility product and ionic product of water); conductometric titrations; transport number, principles of Hittorf's and Moving-boundary method; Wien effect, Debye Falkenhagen effect, Walden's rule.

Ionic Equilibria **(8 Lectures)**

Strong and weak electrolytes, degree of ionization, ionization constant and ionic product of water; ionization of weak acids and bases, pH scale, common ion effect; buffer solutions; derivation of Henderson equation and its applications; buffer capacity, solubility and solubility product of sparingly soluble salts; activity and activity coefficients of ions; qualitative treatment of acid-base titration curves (calculation of pH at various stages); theory of acid-base indicators; selection of indicators and their limitations.

Reference Books

- Atkins, P. W., Paula, J. de Atkins', Physical Chemistry, Oxford University Press.
- Castellan, G. W. Physical Chemistry, Narosa.
- McQuarrie, D. A., Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press.
- Levine, I. N. Physical Chemistry, Tata McGraw-Hill
- Kapoor, K. L. A Textbook of Physical Chemistry, Tata McGraw-Hill.

- Rakshit, P. C. Physical Chemistry, Sarat Book House.
- Moore, W. J. Physical Chemistry, Orient Longman.
- Mortimer, R. G. Physical Chemistry, Elsevier.
- Denbigh, K. The Principles of Chemical Equilibrium, Cambridge University Press.
- Engel, T., Reid, P. Physical Chemistry, Pearson.
- Zemansky, M. W., Dittman, R. H. Heat and Thermodynamics, Tata-McGraw-Hill.
- Rastogi, R. P., Misra, R. R. An Introduction to Chemical Thermodynamics, Vikas.
- Klotz, I. M., Rosenberg, R. M. Chemical Thermodynamics: Basic Concepts and Methods, Wiley.
- Glasstone, S. An Introduction to Electrochemistry, East-West Press.

Course Outcomes

1. To learn the concept about chemical potential, partial properties etc.
2. To acquire detailed knowledge about the Henry's law and the Nernst's distribution law.
3. To study about four colligative properties and phase equilibrium.
4. To gather in-depth knowledge about conductance properties of ions.
5. To learn detailed knowledge about reaction equilibrium of ions.

Core P-8-Physical Chemistry II Laboratory (1 Credit) (30 Lectures)

1. Determination of partition coefficient for the distribution of I_2 between water and organic solvent.
2. Determination of K_{eq} for $KI + I_2 = KI_3$, using partition coefficient between water and organic solvent
3. Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against strong base.

Reference Books

- Viswanathan, B., Raghavan, P. S. Practical Physical Chemistry Viva Books, 2009.
- Mendham, J. A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson.
- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman, 2007.
- Palit, S. R., De, S. K. Practical Physical Chemistry Science Book Agency.
- University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta.
- Levitt, B. P. edited Findlay's Practical Physical Chemistry Longman Group Ltd.
- Gurtu, J. N., Kapoor, R. Advanced Experimental Chemistry, S. Chand & Co. Ltd.

Course Outcomes

1. To become skilled at carrying out acid-base titrations monitoring conductance of ions.

2. To become experienced to evaluate the partition coefficient and equilibrium constant of any chemical reaction.

Minor (MN - 4)

(Credits - 3 + 1)

T-4-Organic Chemistry I (3 Credits) (45 Lectures)

Stereochemistry III (5 Lectures)

Conformation: conformational nomenclature: eclipsed, staggered, gauche, *syn* and *anti*; dihedral angle, torsion angle; energy barrier of rotation, butane gauche interaction; conformational analysis of ethane.

General Treatment of Reaction Mechanism II (10 Lectures)

Reactive intermediates: carbocations, carbanions and free radicals; nucleophiles and electrophiles.

Substitution and elimination reactions: S_N1 and S_N2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination vs. substitution.

Functional Group Chemistry I (30 Lectures)

Aliphatic hydrocarbons: (a) alkanes (up to 5 carbons): preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent; reactions: mechanism for free radical substitution: halogenation; (b) alkenes (up to 5 carbons): preparation: elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction); reactions: cis-addition (alkaline $KMnO_4$) and trans-addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction; (c) alkynes (up to 5 carbons): preparation: acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides; reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Aromatic hydrocarbons: aromaticity, Huckel's rule; Benzene: preparation: from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid; reactions: electrophilic substitution (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), sulphonation and Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene); side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Organometallic compounds: introduction; Grignard reagents: preparations (from alkyl and aryl halide); Reformatsky reaction.

Alcohols and ethers: (a) alcohols (up to 5 carbons): preparation: 1°-, 2°- and 3°- alcohols: using Grignard reagent, reduction of aldehydes, ketones, carboxylic acid and esters; reactions: with sodium, HX (Lucas test), oxidation (alkaline $KMnO_4$, acidic dichromate, concentrated HNO_3); Oppenauer oxidation; (b) diols: preparation (with OsO_4); pinacol-pinacolone rearrangement (with mechanism) (with symmetrical diols only); (d) ethers: preparation: Williamson's ether synthesis; reaction: cleavage of ethers with HI.

Reference Books

- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
- Morrison, R. T., Boyd, R. N., Bhattacharjee, S. K. Organic Chemistry, Pearson Education.
- Singh, M. S. Advanced Organic Chemistry: Reactions and Mechanisms, Pearson.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Pearson Education.
- Bahl, A., Bahl, B. S. Advanced Organic Chemistry, S. Chand.
- Mehta, B., Mehta, M. Organic Chemistry, Prentice-Hall of India Pvt. Ltd.
- Sen Gupta, S. Basic Stereochemistry of Organic Molecules, Oxford University Press.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism, 8th Ed. New Age International.

Course Outcomes

1. To build an understanding about stereochemistry of organic compounds.
2. To comprehend and compare various types of organic reactions, mechanisms and intermediates.
3. To impart in-depth knowledge about the functional group chemistry, which include aliphatic and aromatic hydrocarbons, organometallic compounds, alcohols and ethers.

P-4-Organic Chemistry I Laboratory (1 Credit) (30 Lectures)

Qualitative analysis of single solid organic compound(s)

1. Detection of special elements (N, S, and Cl) in organic compounds by Lassaigne's test.
2. Solubility and classification (solvents: H_2O, dil. HCl, dil. NaOH).
3. Detection of functional groups: aromatic-NO_2, aromatic -NH_2, -COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

Experiments 1 to 3 with unknown (at least 6) solid samples containing not more than two of the above type of functional groups should be done.

Reference Books

- Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
- Nad, A. K., Mahapatra, B., Ghosal, A. An Advanced Course in Practical Chemistry, New Central Book Agency.
- Poddar, S. N., Ghosh, S. P. Practical Chemistry, Book Syndicate Pvt. Ltd.
- Manna, A. K. Practical Organic Chemistry, Books and Allied (P) Ltd.

Course Outcomes

1. To gather knowledge and skills to understand the laboratory methods and tests related to detection of special elements and functional groups in different organic samples.