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.

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

(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

(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.

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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).

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- 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).
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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

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- 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

(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)

T1 - 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

(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 Lab (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

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

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

Multidisciplinary

(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.