MURSHIDABAD UNIVERSITY

Syllabus of 3-Year Degree/4-Year Honours (Research) in

CHEMISTRY

under

National Curriculum and Credit Framework for

Undergraduate Program (as per UGC Guidelines for NEP 2020)

Effective from Academic Session 2025-2026

DEPARTMENT OF CHEMISTRY
MURSHIDABAD UNIVERSITY
Berhampore, Murshidabad
West Bengal, India
Pin 742101

Three -Year Degree/Four-year (8 - Semester) Chemistry Major

Course Structure

Semester – I

Course Code	Course Type	Course Name	Credit	Lectures /Week	Internal Assessment	End Semester	Total Marks
CHE - M – 101 (T)	Major (Theory)	Fundamentals Of Chemistry - I	3	3	15 + 5	40	80
CHE - M – 101 (P)	Major (Practical)	Organic Chemistry - I	1	2	-	20	
CHE - Mi – 101 (T)	Minor (Theory)	General Chemistry-I	3	3	15 + 5	40	80
CHE - Mi – 101 (P)	Minor (Practical)	Inorganic Chemistry - I	1	2	-	20	
CHE - MDC – 101 (T)	MDC*	Chemistry in Daily Life	3	3	15 + 5	40	60
	Ability Enhancement Course (AEC)	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu Or Equivalent Course from SWAYAM or other UGC recognized Platform.	4	4	15 + 5	60	80
CHE - SEC – 101 (T)	Skill Enhancement Course (SEC)	Drugs and pharmaceuticals	3	3	15 + 5	40	60
	Value Added Course (VAC)		2	2	15 + 5	20	40
Total			20	20	120	280	400

*** Students who have not studied chemistry in H. S. level will opt for MDC.**

Semester - II

Course Code	Course Type	Course Name	Credit	Lectures /Week	Internal Assessment	End Semester	Total Marks
CHE - M – 201 (T)	Major (Theory)	Fundamentals Of Chemistry - II	3	3	15 + 5	40	80
CHE - M – 201 (P)	Major (Practical)	Physical Chemistry - I	1	2	-	20	
CHE - Mi – 201 (T)	Minor (Theory)	General Chemistry - I	3	3	15 + 5	40	80
CHE - Mi – 201 (P)	Minor (Practical)	Inorganic Chemistry - I	1	2	-	20	
CHE - MDC – 201 (T)	MDC*	Chemistry in Daily Life	3	3	15 + 5	40	60
	Ability Enhancement Course (AEC)	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu Or Equivalent Course from SWAYAM or other UGC recognized Platform.	4	4	15 + 5	60	80
CHE - SEC – 201 (T)	Skill Enhancement Course (SEC)	Basic Analytical Chemistry	3	3	15 + 5	40	60
	Value Added Course (VAC)		2	2	15 + 5	20	40
	Summer Internship (for outgoing student)						
Total			20	20	120	280	400

*** Students who have not studied chemistry in H. S. level will opt for MDC.**

SEMESTER - I

Course Code: CHE - M – 101 (T)
Course Name: Fundamentals of Chemistry – I
Credit: 03

Theory (Major) **Marks: 60**

Unit-1: Inorganic Chemistry **(15 hours)**

Atomic Structure - Bohr's theory for hydrogen atom (simple mathematical treatment), its limitations and atomic spectra of hydrogen, Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle and its limitations. Wave mechanics: de Broglie wave equation, Qualitative idea of Heisenberg's Uncertainty Principle. Radial and Angular distribution curves. Shapes of s, p and d orbitals. Exchange energy (qualitative idea).

Chemical Periodicity - Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Effective nuclear charge, screening effect, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Inert pair effect. Positions of hydrogen and noble gases.

Unit-2: Organic Chemistry **(15 hours)**

Valence Bond Theory:

Organic compounds: Classification and nomenclature, concept of hybridization, shape of molecules, influence of hybridization on bond properties, resonance, orbital pictures of bonding (sp^3, sp^2, sp, C-C, C-N and C-O systems and s-*cis* and s-*trans* geometry for suitable cases) of organic molecules, Calculation of the formal charges and double bond equivalent (DBE).

Electronic Displacements:

Inductive effect, field effect, mesomeric effect, resonance energy, hyperconjugation, bond polarization and bond polarizability, electromeric effect, steric effect, and steric inhibition of resonance

Physical Properties:

Influence of hybridization on bond properties: Bond dissociation energy (BDE) and bond energy; bond distances, bond angles, and concept of bond angle strain. Comparison of the melting

point/boiling point and solubility of common organic compounds in terms of covalent and non-covalent intermolecular forces, polarity of molecules, dipole moments and relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.

MO theory:

Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π*, n – MOs; concept of HOMO, LUMO and SOMO; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems), ii) cyclic p orbital system (neutral systems: [4]-, [6]- annulenes; charged systems: 3- and 5-membered ring); Hückel's rules for aromaticity up to [10]-annulene; concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about coulomb integral (α) and resonance integral (β); calculation of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.

Unit-3: Physical Chemistry **(15 hours)**

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). Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Calculation of number of molecules having energy ≥ ε, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Real gas and virial equation: 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 behaviour, other equations of state (Berthelot, Dieterici); 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).

Reference Books:

Inorganic Chemistry

1. Lee, J. D. *Concise Inorganic Chemistry,* 5th Ed.*,* Wiley India Pvt. Ltd., 2008.
2. Douglas, B. E. and McDaniel, D. H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
3. Day, M. C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
4. Atkin, P. *Shriver & Atkins' Inorganic Chemistry,* 5th Ed., Oxford University Press (2010).
5. Cotton, F. A., Wilkinson, G. and Gaus, P. L., *Basic Inorganic Chemistry 3rd* Ed.*;* Wiley India.
6. Sharpe, A. G., *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E. A. & Keiter, R. L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th* Ed.*,* Harper Collins 1993, Pearson, 2006.
8. Atkins, P. W. & Paula, J. *Physical Chemistry*, Oxford Press, 2006.
9. Mingos, D. M. P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/(2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., *Ions in solution: basic principles of chemical interactions.* Ellis Horwood (1999).

Organic Chemistry

1. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
2. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
3. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
5. Finar, I. L. Organic Chemistry (Vol. II), Pearson (2002).
6. Fleming, I. Molecular Orbitals and Organic Chemical Reactions, Reference/Student Edition, Wiley, 2009.
7. Graham Solomons, T. W.; Fryhle, C. B. & Snyder, S. A. *Organic Chemistry,* 12th Ed., John Wiley & Sons (2017).
8. McMurry, J. E. *Fundamentals of Organic Chemistry*, 7th Ed., Cengage Learning India Edition (2013).
9. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi(1988).
10. Smith, M. B; March, J. Advance Organic Chemistry, Wiley-interscience, A John Wiley & Sons, Inc. Publication.

Physical Chemistry

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press.

2. Castellan, G. W. Physical Chemistry, Narosa.
3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press.
4. Engel, T. & Reid, P. Physical Chemistry, Pearson.
5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill.
6. Maron, S. & Prutton Physical Chemistry.
7. Ball, D. W. Physical Chemistry, Thomson Press.
8. Mortimer, R. G. Physical Chemistry, Elsevier.
9. Laidler, K. J. Chemical Kinetics, Pearson.
10. Glasstone, S. & Lewis, G. N. Elements of Physical Chemistry.
11. Rakshit, P.C., Physical Chemistry Sarat Book House.

Course Code: CHE - M – 101 (P)
Course Name: Organic Practical – I
Credit: 01

Practical (Major) **Marks: 20**

Qualitative Analysis of Single Solid Organic Compounds: **(30 hours)**

(i) Detection of special elements (N, S, Cl) by Lassaigne's test.

(ii) Solubility and classification (solvents: H_2O, 5% HCl, 5% NaOH and 5% $NaHCO_3$)

(iii) Determination of the melting point of the given compound.

(iv) Detection of the following functional groups by systematic chemical tests: aromatic amino (Ar-NH_2), aromatic nitro (Ar-NO_2), amido (-$CONH_2$, including imide), anilido (ArNHCO-), phenolic (–OH), carboxylic acid (-COOH), carbonyl (-CHO and >C=O), olefinic unsaturation.

(v) Preparation, purification and determination of melting point of a crystalline derivative of the given compound.

(vi) 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 derivatization in known and unknown (at least six) organic compounds.

Reference Books:

1. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
2. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

4. Clarke, H. T., A Handbook of Organic Analysis (Qualitative and Quantitative), Fourth Edition, CBS Publishers and Distributors (2007).

Course Code: CHE - Mi – 101 (T)
Course Name: General Chemistry – I
Credit: 03

Theory (Minor) **Marks: 60**

Unit-1: Inorganic Chemistry **(15 hours)**

Atomic Structure

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle and its limitations

Periodic Properties

Classification of elements on the basis of electronic configuration: General characteristics of s-, p-, d- and f-block elements, positions of hydrogen and noble gases, atomic and ionic radii, ionization potential, electron affinity and electronegativity, periodic and group-wise variation of above properties in respect of s- and p- block elements.

Acids and Bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents, Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept, hard and soft acids and bases (HSAB concept), applications of HSAB process, acidity and basicity of common organic compounds.

Unit-2: Organic Chemistry **(15 hours)**

Fundamentals of Organic Chemistry

Concept of hybridization, structure and shape of organic molecules.

Electronic displacements: inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

Stereochemistry

Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (simple axis,

plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.

Unit-3: Physical Chemistry **(15 hours)**

Kinetic Theory of Gases and Real 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); Rate of effusion.

Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its pressure and volume correction in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states.

Reference Books:

Inorganic Chemistry

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010). 11
4. Cotton, F. A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry 3rd Ed.; Wiley India.
5. Sharpe, A. G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
6. Huheey, J. E.; Keiter, E. A. & Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.

Organic Chemistry

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
4. Sengupta, Subrata. Basic Stereochemistry of Organic molecules.

5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, Eighth edition, New Age International, 2014.
6. Bahl, A. & Bahl, B. S. Advanced Organic Chemistry, S. Chand, 2010.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Smith, M. B; March, J. Advance Organic Chemistry, Wiley-interscience, A John Wiley & Sons, Inc. Publication.

Physical Chemistry

1. Barrow, G. M. Physical Chemistry, Tata McGraw-Hill (2007).
2. Castellan, G. W. Physical Chemistry, 4th Ed. Narosa (2004).
3. Kotz, J. C., Treichel, P. M. & Townsend, J. R. General Chemistry, Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B. H. University Chemistry, 3rd Ed. Narosa (1998).
5. Petrucci, R. H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Chugh, K. L., Agnish, S. L. A Text Book of Physical Chemistry, Kalyani Publishers.
7. Bahl, B. S., Bahl, A., Tuli, G. D., Essentials of Physical Chemistry, S. Chand & Co. ltd.
8. Palit, S. R., Elementary Physical Chemistry, Book Syndicate Pvt. Ltd.
9. Mandal, A. K. Degree Physical and General Chemistry, Sarat Book House.
10. Pahari, S., Physical Chemistry, New Central Book Agency.
11. Pahari, S., Pahari, D., Problems in Physical Chemistry, New Central Book Agency.

Course Code: CHE - Mi – 101 (P)
Course Name: Inorganic Practical – I
Credit: 01

Practical (Minor) **Marks: 20**
(30 hours)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating with $KMnO_4$.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009
2. Ghosal, Mahapatra & Nad, *An Advanced course in practical Chemistry,* New Central Book Agency.
3. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta, 2003.
4. Das, S. C., Chakraborty, S. B., *Practical Chemistry.*
5. Mukherjee, K. S. *Text book on Practical Chemistry*, New Oriental Book Agency.

Multidisciplinary Course
Course Code: CHE - MDC – 101 (T)
Course Name: Chemistry in Daily Life
Credit: 03

Theory (MDC) **Marks: 60**

1. Food Additives **(6 hours)**

Food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequestrants − uses and abuses of these substances in food beverages.

2. Drugs and Pharmaceuticals **(8 hours)**

Structure and function, antipyretic and analgesic drugs - aspirin, paracetamol, ibuprofen, sulphadiazine, quinine, chloroquine, phenobarbital, metronidazole.

3. Vitamins **(4 hours)**

Basic idea on vitamins, uses of some vitamins: Vit-A, Vit-K, Vit-E, Vit-C, Vit-D and Vit-B12

4. Fats and Oils **(8 hours)**

Natural fat, edible and inedible oil of vegetable origin; common fatty acids; glycerides; hydrogenation of unsaturated oil, production of vanaspati and margarine.

5. Soaps and Detergents **(6 hours)**

Production of toilet and washing soaps; enzyme-based detergents, detergent powder; liquid soaps.

6. Pesticides **(5 hours)**

Common pesticides: production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin.

7. Chemistry of Fuels: **(8 hours)**

Conventional and non-conventional energy sources, classification of fuels, calorific values of fuels like kerosene, coal, coal gas, petrol, liquefied petroleum gas, octane number, bio gas.

Reference Books:

1. Gayatri Baidya, Textbook of Food Chemistry, Book Rivers.
2. Thapar, Food Chemistry, Pacific Book International.
3. Sengupta, S. Application Oriented Chemistry, Book Syndicate Pvt. Ltd., 2000.
4. Singh, K. Chemistry in Daily Life: Third Edition Kindle Edition.
5. Lassar-Cohn, Chemistry in Daily Life, Publisher, Read Books, 2007.
6. Sethi, A. Conceptual Organic Chemistry; New Age International Publisher.

7. Parmar, V. S. A Text Book of Organic Chemistry, S. Chand & Sons.
8. Madan, R. L. Organic Chemistry, S. Chand & Sons.
9. Ekambaram, S. General Chemistry, Pearson.
10. Mandal, S.K., Pharmaceutical Chemistry and Production: An Introductory Textbook Rebeca Ghanta; Bentham Science Publishers 2022, ISBN: 978-1-68108-890-7

Skill Enhancement Course (SEC)

Course Code: CHE - SEC – 101 (T)

Course Name: Drugs and Pharmaceuticals

Credit: 03

Theory (SEC) **Marks: 60**

1. Drugs & Pharmaceuticals: **(25 hours)**

Basic concepts of drug discovery, design and development; properties, uses and toxicity of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (aspirin, paracetamol, ibuprofen); 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); antacid (magnesium bisilicate).

2. Fermentation: **(20** hours**)**

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.

Reference Books:

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V. K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W. O., Lemke, T. L. & William, D. A.: Principles of Medicinal Chemistry, 4th ed., B. I. Waverly Pvt. Ltd. New Delhi.
4. Ghosh, J., A Textbook of Pharmaceutical Chemistry, S. Chand Publishers.

SEMESTER-II

Course Code: CHE - M – 201 (T)

Course Name: Fundamentals of Chemistry – II

Credit: 03

Theory (Major) **Marks: 60**

Unit-1: Inorganic Chemistry **(15 hours)**

Acid-Base Concept: Arrhenius concept, theory of solvent system (H_2O, NH_3, SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, solvent levelling and differentiating effects. Superacids, proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralization curves; indicator, choice of indicators. Solubility product, common ion effect.

Chemical Bonding:

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its application and limitations, packing of ions in crystals Born-Landé equation with derivation and importance, Kapustinskii expression for lattice energy, Madelung constant, Born-Haber cycle.

Covalent bond: Polarizing power and polarizability, ionic potential, Fazan's rules, Lewis structures, formal charge, Valence Bond Theory- hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and nonequivalent hybrid orbitals, Bent's rule, dipole moments, VSEPR theory, and shapes of molecules.

Unit-2: Organic Chemistry **(15 hours)**

Stereochemistry-I:

Stereochemistry of acyclic compounds: concept of chirality; symmetry elements and point groups; asymmetric and dissymmetric molecules; racemic compounds, optical activity, optical rotation, specific rotation, molar rotation, specific rotation of mixture, Biot's law.

Representation of molecules: Fischer, sawhorse, flying-wedge and Newman projection formulae and their intertranslations.

Stereoisomerism: enantiomers and diastereomers; epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s).

Relative and absolute configuration: D/L and R/S descriptors; erythro/threo and meso descriptors of stereoisomers; syn/anti descriptors 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.

Mechanistic Classification: Homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; ionic and radical (definition and example) reactions. Different reaction types: addition, elimination and substitution reactions (definition and example). Curly arrow rules in the representation of mechanistic steps. Reagent type: electrophiles and nucleophiles. Electrophilicity and nucleophilicity in terms of FMO approach (Acceptor/Donar).

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

Unit-3: Physical Chemistry **(15 hours)**

Chemical Thermodynamics – I:

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, H; 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. 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.

Chemical Thermodynamics – II:

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 involved in various processes and transformations; Entropy and unavailable work; Free energy functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium. 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 Thermodynamics-III:

Nernst heat theorem, Third law, Absolute entropy, Planck's law, Calculation of entropy.

Reference Books:

Inorganic Chemistry:

1. Lee, J. D. *Concise Inorganic Chemistry,* 5th Ed.*,* Wiley India Pvt. Ltd., 2008.
2. Douglas, B. E. and McDaniel, D. H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
3. Day, M. C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
4. Atkin, P. *Shriver & Atkins' Inorganic Chemistry,* 5th Ed., Oxford University Press (2010).
5. Cotton, F. A., Wilkinson, G. and Gaus, P. L., *Basic Inorganic Chemistry 3rd Ed.;* Wiley, India.
6. Sharpe, A. G., *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E. A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structureand Reactivity 4th Ed.,* Harper Collins 1993, Pearson,2006.
8. Atkins, P. W. & Paula, J. *Physical Chemistry*, Oxford Press, 2006.
9. Mingos, D. M. P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/ (2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., *Ions in solution: basic principles of chemical interactions.* Ellis Horwood (1999).

Organic Chemistry:

1. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
2. Eames, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
3. Robinson, M. J. T., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
4. Sengupta, Subrata. Basic Stereochemistry of Organic molecules.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, Eighth edition, New Age International, 2014.
6. Ernest L. Eliel; Stereochemistry of Organic Compounds; Wiley-India.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Smith, M. B; March, J. Advance Organic Chemistry, Wiley-interscience, A John Wiley & Sons, Inc. Publication.

Physical Chemistry:

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press.

2. Castellan, G. W. Physical Chemistry, Narosa.
3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press.
4. Engel, T. & Reid, P. Physical Chemistry, Pearson.
5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill.
6. Maron, S. & Prutton Physical Chemistry.
7. Ball, D. W. Physical Chemistry, Thomson Press.
8. Mortimer, R. G. Physical Chemistry, Elsevier.
9. Laidler, K. J. Chemical Kinetics, Pearson.
10. Glasstone, S. & Lewis, G. N. Elements of Physical Chemistry.
11. Rakshit, P. C., Physical Chemistry Sarat Book House.
12. Zemansky, M. W. & Dittman, R. H. Heat and Thermodynamics, Tata-McGraw-Hill.
13. Rastogi, R. P. & Misra, R. R. An Introduction to Chemical Thermodynamics, Vikas.
14. Clauze & Rosenberg, Chemical Thermodynamics.

Course Code: CHE - M – 201 (P)
Course Name: Physical practical – I
Credit: 01

Practical (Major) **Marks: 20**
(30 hours)

1. Determination of pH of unknown solution (buffer), by color matching method.
2. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate.
3. Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer.
4. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

Reference Books:

1. Palit, S.R., De, S. K. Practical Physical Chemistry Science Book Agency.
2. Levitt, B. P. edited Findlay's Practical Physical Chemistry Longman Group Ltd.
3. Gurtu, J. N., Kapoor, R., Advanced Experimental Chemistry S. Chand & Co. Ltd.
4. R. Mukhopadhyay, P. Chatterjee., Advanced Practical Chemistry, Books and Allied (P) Ltd.
5. S. Ghosh, M. D. Sarma, D. Majumdar, S. Mana,; Chemistry in Laboratory, Santra Publication.

Course Code: CHE - Mi – 201 (T)
Course Name: General Chemistry – I
Credit: 03

Theory (Minor) **Marks: 60**

Unit-1: Inorganic Chemistry **(15 hours)**

Atomic Structure

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle and its limitations

Periodic Properties

Classification of elements on the basis of electronic configuration: General characteristics of s-, p-, d- and f-block elements, positions of hydrogen and noble gases, atomic and ionic radii, ionization potential, electron affinity and electronegativity, periodic and group-wise variation of above properties in respect of s- and p- block elements.

Acids and Bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents, Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept, hard and soft acids and bases (HSAB concept), applications of HSAB process, acidity and basicity of common organic compounds.

Unit-2: Organic Chemistry **(15 hours)**

Fundamentals of Organic Chemistry

Concept of hybridization, Structure and shape of organic molecules.

Electronic displacements: inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

Stereochemistry

Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (simple axis, plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.

Unit-3: Physical Chemistry **(15 hours)**

Kinetic Theory of Gases and Real 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); Rate of effusion.

Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its pressure and volume correction in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states.

Reference Books:

Inorganic Chemistry

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010). 11
4. Cotton, F. A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry 3rd Ed.; Wiley India.
5. Sharpe, A. G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
6. Huheey, J. E.; Keiter, E. A. & Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.

Organic Chemistry

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
4. Sengupta, Subrata. Basic Stereochemistry of Organic molecules.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, Eighth edition, New Age International, 2014.
6. Bahl, A. & Bahl, B. S. Advanced Organic Chemistry, S. Chand, 2010.

7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Smith, M. B; March, J. Advance Organic Chemistry, Wiley-interscience, A John Wiley & Sons, Inc. Publication.

Physical Chemistry

1. Barrow, G. M. Physical Chemistry, Tata McGraw-Hill (2007).
2. Castellan, G. W. Physical Chemistry, 4th Ed. Narosa (2004).
3. Kotz, J. C., Treichel, P. M. & Townsend, J. R. General Chemistry, Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B. H. University Chemistry, 3rd Ed. Narosa (1998).
5. Petrucci, R. H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Chugh, K. L., Agnish, S. L. A Text Book of Physical Chemistry, Kalyani Publishers.
7. Bahl, B. S., Bahl, A., Tuli, G. D., Essentials of Physical Chemistry, S. Chand & Co. ltd.
8. Palit, S. R., Elementary Physical Chemistry, Book Syndicate Pvt. Ltd.
9. Mandal, A. K. Degree Physical and General Chemistry, Sarat Book House.
10. Pahari, S., Physical Chemistry, New Central Book Agency.
11. Pahari, S., Pahari, D., Problems in Physical Chemistry, New Central Book Agency.

Course Code: CHE - Mi – 201 (P)
Course Name: Inorganic practical – I
Credit: 01

Practical (Minor) **Marks: 20**
(30 hours)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating with $KMnO_4$.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009
2. Ghosal, Mahapatra & Nad, *An Advanced course in practical Chemistry,* New Central Book Agency.
3. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta, 2003.
4. Das, S. C., Chakraborty, S. B., *Practical Chemistry.*
5. Mukherjee, K. S. *Text book on Practical Chemistry*, New Oriental Book Agency.

Multidisciplinary Course
Course Code: CHE - MDC – 201 (T)
Course Name: Chemistry in Daily Life
Credit: 03

Theory (MDC) **Marks: 60**

1. Food Additives **(6 hours)**

Food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequestrants − uses and abuses of these substances in food beverages.

2. Drugs and Pharmaceuticals **(8 hours)**

Structure and function, antipyretic and analgesic drugs - aspirin, paracetamol, ibuprofen, sulphadiazine, quinine, chloroquine, phenobarbital, metronidazole.

3. Vitamins **(4 hours)**

Basic idea on vitamins, uses of some vitamins: Vit-A, Vit-K, Vit-E, Vit-C, Vit-D and Vit-B12

4. Fats and Oils **(8 hours)**

Natural fat, edible and inedible oil of vegetable origin; common fatty acids; glycerides; hydrogenation of unsaturated oil, production of vanaspati and margarine.

5. Soaps and Detergents **(6 hours)**

Production of toilet and washing soaps; enzyme-based detergents, detergent powder; liquid soaps.

6. Pesticides **(5 hours)**

Common pesticides: production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin.

7. Chemistry of Fuels: **(8 hours)**

Conventional and non-conventional energy sources, classification of fuels, calorific values of fuels like kerosene, coal, coal gas, petrol, liquefied petroleum gas, octane number, bio gas.

Reference Books:

1. Gayatri Baidya, Textbook of Food Chemistry, Book Rivers.
2. Thapar, Food Chemistry, Pacific Book International.
3. Sengupta, S. Application Oriented Chemistry, Book Syndicate Pvt. Ltd., 2000.
4. Singh, K. Chemistry in Daily Life: Third Edition Kindle Edition.
5. Lassar-Cohn, Chemistry in Daily Life, Publisher, Read Books, 2007.
6. Sethi, A. Conceptual Organic Chemistry; New Age International Publisher.

7. Parmar, V. S. A Text Book of Organic Chemistry, S. Chand & Sons.
8. Madan, R. L. Organic Chemistry, S. Chand & Sons.
9. Ekambaram, S. General Chemistry, Pearson.
10. Mandal, S.K., Pharmaceutical Chemistry and Production: An Introductory Textbook Rebeca Ghanta; Bentham Science Publishers 2022, ISBN: 978-1-68108-890-7

Skill Enhancement Course (SEC)

Course Code: CHE - SEC – 201 (T)

Course Name: Basic Analytical Chemistry

Credit: 03

Theory (SEC) **Marks: 60**

1. General principle **(4 Hours)**

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, role of significant figures.

2. Analysis of soil **(6 Hours)**

Composition, pH of soil samples, estimation of calcium and magnesium content.

3. Complexometry **(5 Hours)**

Complexometric titrations, chelation, chelating agents, use of indicators. Estimation of calcium and magnesium ions as calcium carbonate by complexometric titration.

4. Analysis of water **(5 Hours)**

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of Biological Oxygen Demand (BOD).

5. Analysis of food products **(5 Hours)**

Nutritional value of foods, idea about food processing and food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. Analysis of preservatives and colouring matter.

6. Chromatography **(10 Hours)**

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc., column chomatography, ion-exchange chromatography, etc., determination of ion exchange

capacity of anion /cation exchange resin. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).

7. Analysis of cosmetics (5 Hours)

Major and minor constituents of cosmetics and their functions, analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

8. Suggested Instrumental demonstrations (5 Hours)

Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks.

Reference Books:

1. 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.
2. Skoog, D. A., Holler, F. J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India, Edition, 2007.
3. Skoog, D. A.; West, D. M. & Holler, F. J. Analytical Chemistry: An Introduction sixth Ed., Saunders, College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D. C. Quantitative Chemical Analysis, 9th Ed. Macmillan Education, 2016.
5. Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992.
7. Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
8. Cooper, T. G. The Tools of Biochemistry, John Wiley & Sons, N. Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
10. Mendham, J., A. I. Vogel' s Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
11. Robinson, J. W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).
12. Christian, G. D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.