MAHARSHI DAYANAND SARASWATI UNIVERSITY AJMER

पाठ्यक्रम

SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY
FACULTY OF SCIENCE
B.Sc. with Chemistry
B. Sc. Semester I & II Examination
(w.e.f. 2023-24)
B. Sc. Semester III & IV Examination
(w.e.f. 2024 -25)
B. Sc. Semester V & VI Examination
(w.e.f. 2025 -26)

□□□□□□□ 2023

महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर
MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER

B.Sc. with Chemistry (First and Second Semester)

1. There shall be six Semesters in all with two Semesters in one Year in B.Sc. with Chemistry, a 3-year UG Programme. A Semester comprise of One Theory Course divided into three independent units and One Practical Course each with a specific Course Code Number, Course Title and a total of 06 Credits (04 Theory + 02 Practicals). Each Theory Course is of 60 Periods of one hour each and assigned 04 credits. Each Practical Course is of 30 periods of two hours each and assigned 02 credits.
   Degree of the three year UG Programme will be awarded to candidates who satisfy the minimum credit requirement as per university policy.

2. The maximum marks for each Semester Examination will be 150 [Theory -100 marks (70 external assessment and 30 internal assessment) + Practicals - 50 marks]. Theory Examination at the End of each Semester will be of three hours duration and of 70 marks and Practical Examination will be of four hours duration and of 50 marks. There shall ber Internal Assessment of 30 marks in each Theory Course on continuous assessment basis at the Department/ College level and External Assessment of 70 marks in the End of each Semester at the University level. The candidate will have to pass both in Internal Assessment and External Assessment separately in each Theory Course. In Practical course there is External Assessment only in the end of Each Semester. It will be necessary for a candidate to pass in theory and practical examination separately. Criteria for pass percentage and grade system to be followed will be as per university policy.
3. Internal Assessment of 30 marks is distributed as follows:

One Written Test	20 marks
One Assignment including creative skill	05 marks
Attendance	05 marks (for 75% attendance - 3 marks; upto 90% attendance -04 marks and from 91 to 100% attendance - 05 marks)

Each theory course is assigned three periods of one hour each of teaching per week and each Practical Course is assigned two continuous periods of one hour each. The scheme of Examination of Practical Examination of 50 marks is given at the end of the Practical Course.

Scheme of examination for end of semester examination applicable to all undergraduate courses (Pass Course) for Theory Examination of 70 marks is as follows:

The question paper of semester Examination for the Disciplinary Centric Core Course (DCCC), Discipline specific elective (DSE), Ability Enhancement Course (AEC), Value Added Course (VAC) and Skill Enhancement Course (SEC) will be of 70 marks and it will be divided in two parts i.e. Part A and Part-B.

Part-A will consist of 10 compulsory questions. There will be at least three questions from each unit and answer to each question shall be limited upto 50 words. Each question will carry two marks. **Total 20 Marks.**

Part-B will consist of 10 questions. At least three questions from each unit be set and student will have to answer five questions, selecting at least one question from each unit. The answer to each question shall be limited to 400 words. Each question carries10 Marks. **Total 50 Marks.**

Semester I

CHEMISTRY-CHE 5.5 01T-CO: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & HYDROCARBONS

(Credits: Theory-04; Practicals - 02) Theory:60 Lectures

Course Objectives: This course aims at giving students theoretical understanding about the basic constituents of matter – atoms, ions and molecules in terms of their electronic structure and reactivity. Structure and bonding in/of these are to be dealt with basic quantum chemistry treatment. Reactivity of chemical species based on their electron transfer affinity is introduced. Understand the concepts of Organic reactions and techniques of writing the movement of electrons, bond breaking, bond forming 6. Learn the Concept of aromaticity, resonance, hyper conjugation, etc. Understanding the mechanism of nucleophilic, electrophilic reaction Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to volumetric titrations.

Learning Outcome: On successful completion, students would have clear understanding of the concepts related to atomic and molecular structure, chemical bonding, aliphatic and aromatic hydrocarbons. Students will also have hands-on experience of calibration of glasswares, qualitative analysis of inorganic ions, standard solution preparation in different concentration units and learn volumetric estimation through acid-base.

UNIT-I

Atomic Structure: Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2. Significance of quantum numbers, radial and angular wave functions and probability distribution curves. Shapes of s, p and d atomic orbitals, nodal planes. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Electronic configuration of the elements (s-block, p-block, and first series of d-block elements). Stability of half-filled and completely filled orbitals. Effective nuclear charge. (12 Lectures)

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. (8 Lectures)

UNIT-II

Fundamentals of Organic Chemistry: Classification of Organic Compounds and Nomenclature, Hybridization, Shapes of molecules; Influence of hybridization on bond properties. Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Structure, shape and reactivity of organic molecules; Homolytic and

Heterolytic fission with suitable examples; Curved arrow notations; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of reactive intermediates: Carbocations, Carbanions, Free radicals, and Carbenes; Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values; Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions; Methods for determination of organic reaction mechanisms; Calculation of Formal charges on intermediate and other ionic species (12 Lectures)

Stereochemistry of Organic Compounds: Concept of isomerism, types of isomerism, Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomers and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems). Resolution of enantiomers, inversion, retention and racemization. (8 Lectures)

UNIT-III

Hydrocarbons: Alkanes (Upto 5 Carbons)- Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent Reactions: Free radical Substitution: Halogenation. **Alkenes (Upto 5 Carbons)-** Preparation: Elimination reactions, Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule), cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction); Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markovnikov's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation. **Alkynes (Upto 5 Carbons)-** Preparation: Acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. (12 Lectures)

Aromatic Compounds: Nomenclature of benzene derivatives, Aryl group, Aromatic nucleus and side chain, Structure of Benzene: Molecular Formula and Kekule Structure, stability and carbon-carbon bond length of Benzene, Molecular orbital structure of Benzene. Aromaticity-Hückel's rule, aromatic character of arenes, cyclic carbocations, carbanions and heterocyclic compounds with suitable examples. (8 Lectures)

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd edWiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014). McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
6. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education,2000. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.

7. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

CHEMISTRY LAB- CHE 5.5 01 P-CO: QUALITATIVE INORGANIC ANALYSIS, ELEMENTAL ANALYSIS OF ORGANIC COMPOUNDS, LABORATORY TECHNIQUES

(Credits: Practicals-02) **30 Periods of two hours each**

A. Major Exercise **(15 marks)**

1.Qualitative inorganic analysis Analysis of simple salt containing two anions and two cations from the following Anions: Carbonate, sulfate, chloride, bromide, acetate, nitrate, borate, phosphate. cations: Lead, copper, iron, aluminum, zinc, manganese, nickel, calcium, strontium, barium, potassium and ammonium (including interfering radicals).

B. Minor Exercise **(10 marks)**

1.Determination of Melting point of given Organic compound.

2.Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

C. Minor Exercise **(10 marks)**

1. Calibration of pipette, burette, and thermometer.

2. Purification of organic compounds by crystallization.

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Scheme of Practical Examination & Distribution of marks

Max. Marks: 50 **Time: 4 hours.**

1. **Major Exercise (one) - 15 marks**
2. **Minor Exercise (B) - 10 marks**
3. **Minor Exercise (C) - 10 marks**
4. **Record - 5 marks**
5. **Viva-voce - 10 marks**

Semester II

CHEMISTRY-CHE 5.5 02T-CE: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Course Objectives: The objective of this paper is to develop basic understanding of the chemical energetics, laws of thermodynamics, chemical and ionic equilibrium. It provides basic understanding of the behaviour of electrolytes and their solutions. It acquaints the students with the functional group approach to study organic chemistry. To establish applications of this concept structure, methods of preparation and reactions for the following classes of compounds: Aromatic hydrocarbons, alkyl and aryl halides, alcohols, phenols and ethers, aldehydes and ketones are described. This course helps the students to relate the structure of an organic compound to its physical and chemical properties.

Learning Outcome: By the end of this course, students will be able to: Understand the laws of thermodynamics, thermochemistry and equilibria. Understand the concept of pH and its effect on the various physical and chemical properties of the compounds. Use the concepts learnt to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium. Understand the fundamentals of functional group chemistry through the study of methods of preparation, properties and chemical reactions with underlying mechanisms. Use concepts learnt to understand stereochemistry of a reaction and predict the reaction outcome. Design newer synthetic routes for various organic compounds. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to volumetric titrations.

UNIT-I

Chemical Energetics: Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances. (8 Lectures)

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gasses.

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. (12 Lectures)

UNIT-II

Aromatic hydrocarbons: Industrial preparation of benzene from coal tar, Preparation of benzene from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions of benzene: Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Crafts reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain

oxidation of alkyl benzenes (upto 4 carbons on benzene) with their mechanism; Energy profile diagram; Activating and deactivating substituents; Orientation and ortho/para ratio (8 Lectures)

Alkyl and Aryl Halides: Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN^1, SN^2 and SN^1) reactions. Preparation: from alkenes and alcohols; Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution. **Aryl Halides** Preparation: (Chloro, bromo and iodo-benzene): from phenol, Sandmeyer & Gattermann reactions; Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$); Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides. (12 Lectures)

UNIT-III

Alcohols, Phenols and Ethers (Upto 5 Carbons) & Carbonyl compounds: Alcohols- Preparation: Preparation of 1º, 2º and 3º alcohols using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters; Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation. **Diols: (Upto 6 Carbons)** oxidation of diols, Pinacol-Pinacolone rearrangement. (8 Lectures)

Phenols: Preparation- Cumene hydroperoxide method, from diazonium salts; Reactions: Electrophilic substitution, Nitration, halogenation and sulphonation. Reimer Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. **Ethers (aliphatic and aromatic):** Preparation, Cleavage and autooxidation.
Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation- from acid chlorides and from nitriles; Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives; Iodoform test, Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction, Meerwein-Pondorff Verley reduction. (12 Lectures)

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007). Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
2. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
3. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
4. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985). 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).
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988). Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
8. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
9. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

CHEMISTRY LAB- CHE 5.5 02 P-CE : CHEMICAL ENERGETICS, EQUILIBRIA&FUNCTIONALORGANICCHEMISTRY

(Credits: Practicals-02) **30 Periods of two hours each**

A. Major Exercise (15 marks)

1. To determine the percentage composition of a given mixture (non interacting systems) by viscosity method.
2. To determine the percentage composition of a given binary mixture by surface tension method.
3. To determine specific reaction rate of hydrolysis of methyl acetate/ethyl acetate catalysed by hydrogen ion at room temperature.

B. Minor Exercise (10 marks)

1. To study the distribution of Iodine between water and carbon tetrachloride.
2. To study the distribution of Benzoic acid between benzene and water

C. Minor Exercise (10 marks)

1. Determination of mixed melting point of urea and cinnamic acid in various compositions (1:4, 1:1,4:1)

2.Sublimation of Naphthalene, Camphor, Phathalic acid and Succinic acid

Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011)

Scheme of Practical Examination & Distribution of marks

Max. Marks: 50 **Time: 4 hours.**

1.One Major Exercise (A) - 15 marks
2.One Minor Exercise (B) - 10 marks
3.One Minor Exercise (C) - 10 marks
4.Record - 5 marks
5.Viva-voce - 10 marks