Chaudhary Devi Lal University Sirsa

(Establishment by the State Legislature Act 9 of 2003)

B.Sc. Physical Sciences / Life Sciences

(Multidisciplinary)

Scheme of Examination & Syllabus
of
Under Graduate Programmes
as per NEP 2020
1st to 4nd Semester

Session 2024-25

DEPARTMENT OF CHEMISTRY

Chaudhary Devi Lal University

Sirsa-125055

Table: 1 Course and Credit Scheme of Under Graduate Programmes of Physical Sciences/ Life Sciences (Multidisciplinary)

Sr. No.	Course Code	Course Title	Credits			Level
Discipline Specific Courses (DSC)			**T**	**P**	**Total**	
1	BSC/CHEM/MD/1/DSC/101	Chemistry-I	3	1	4	100
2	BSC/CHEM/MD/2/DSC/151	Chemistry-II	3	1	4	100
3	BSC/CHEM/MD/3/DSC/201	Chemistry-III	3	1	4	200
4	BSC/CHEM/MD/4/DSC/251	Chemistry-IV	3	1	4	200

Sr. No.	Course Code	Course Title	Credits			Level
Minor (MIC) Courses in Chemistry			**T**	**P**	**Total**	
1	BSC/CHEM/MD/1/MIC/101	Chemistry Minor -I	2	--	2	100
2	BSC/CHEM/MD/2/MIC/151	Chemistry Minor –II	2	--	2	100
	BSC/CHEM/MD/3/MIC/201	Chemistry Minor –III	3	1	4	200
	BSC/CHEM/MD/4/MIC/251	Chemistry Minor -IV	3	1	4	200
Multidisciplinary Courses (MDC) in Chemistry			**L**	**P**	**Total**	**Level**
1	BSC/BCOM/BA/CHEM/MD/1/MDC/101	Introductory Chemistry-I	2	1	3	100
2	BSC/BCOM/BA/CHEM/MD/1/MDC/151	Introductory Chemistry-II	2	1	3	100
3	BSC/BCOM/BA/CHEM/MD/1/MDC/201	Introductory Chemistry-III	2	1	3	200
Skill Enhancement Courses (SEC) in Chemistry			**L**	**P**	**Total**	**Level**
1	BSC/CHEM/MD/1/SEC/101	Pesticide Chemistry	2	1	3	100
2	BSC/CHEM/MD/1/SEC/102	Fuel Chemistry	2	1	3	100
3	BSC/CHEM/MD/2/SEC/151	Basic Analytical Chemistry	2	1	3	100
4	BSC/CHEM/MD/2/SEC/152	Green Methods in Chemistry	2	1	3	100
5	BSC/CHEM/MD/3/SEC/201	Chemistry of Cosmetics & Perfumes	2	1	3	200

Table: 2 Semester wise Course code and Title along with credit details
Under Graduate Programmes of Physical Sciences /Life Sciences (Multidisciplinary)

Course Code	Course Title	Credits				Marks
Semester I						
		T		**P**	**Total**	
BSC/CHEM/MD/1/DSC/101	Chemistry - I	3		1	4	100
	anyone from Science discipline				4	100
	anyone from Science discipline				4	100
BSC/CHEM/MD/1/MIC/101	Chemistry Minor - I	2		-	2	50
BSC/CHEM/MD/1/SEC/101 or BSC/CHEM/MD/1/SEC/102	Pesticide Chemistry or Fuel Chemistry	2		1	3	75
AEC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2		-	2	50
VAC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2		-	2	50
BSC/BCOM/BA/CHEM/MD/1/MDC/101	Introductory Chemistry-I	2		1	3	75
Total					**24**	**600**
Semester II						
BSC/CHEM/MD/2/DSC/151	Chemistry - II	3		1	4	100
	anyone from Science discipline				4	100
	anyone from Science discipline				4	100
BSC/CHEM/MD/2/MIC/151	Chemistry Minor - II	2		-	2	50
BSC/CHEM/MD/2/SEC/151 or BSC/CHEM/MD/2/SEC/152	Basic Analytical Chemistry Or Green Methods in Chemistry	2		1	3	75
AEC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2		-	2	50
VAC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2		-	2	50
BSC/BCOM/BA/CHEM/MD/2/MDC/151	Introductory Chemistry-II	2		1	3	75
Total					**24**	**600**

Table: 3 Semester wise Course code and Title along with credit details
Under Graduate Programmes of Physical Sciences / Life Sciences (Multidisciplinary)

Course Code	Course Title	Credits				Marks
Semester III						
		T		**P**	**Total**	
BSC/CHEM/MD/3/DSC/201	Chemistry - III	3		1	4	100
	anyone from Science discipline					100
	anyone from Science discipline					100
BSC/CHEM/MD/3/MIC/201	Chemistry Minor - III	3		1	4	100
BSC/CHEM/MD/3/SEC/201	Chemistry of Cosmetics & Perfumes	2		1	3	75
AEC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2			2	50
VAC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2			2	50
BSC/BCOM/BA/CHEM/MD/3/MDC/201	Introductory Chemistry-III	2		1	3	75
Total					**24**	**650**
Semester IV						
BSC/CHEM/MD/4/DSC/251	Chemistry - IV	3		1	4	100
	anyone from Science discipline				4	100
	anyone from Science discipline				4	100
BSC/CHEM/MD/4/MIC/251	Chemistry Minor - IV	3		1	4	100
AEC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2		-	2	50
VAC	To be selected from the central pool of Multidisciplinary/Value Added Courses	2		-	2	50
Total					**24**	**500**

FIRST SEMESTER

BSC/CHEM/MD/1/DSC/101

Chemistry - I

DURATION: 3+2 HOURS **MAXIMUM MARKS: 100**
Credit: 3+1 = 4 **Theory: 75 (External 50 + Internal 25)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: Enable to understand the basics of atomic structure and periodic properties.
CO2: To learn about the gaseous state & solid state.
CO3: Get knowledge about the structure & bonding and stereochemistry of organic compounds.
CO4: To learn about the redox titrations and synthesis of organic compounds.

Unit-I

Atomic Structure

Dual behaviour of matter and radiation, de Broglie's relation, Heisenberg's uncertainty principle, concept of atomic orbitals, significance of quantum numbers, radial and angular wave functions, normal and orthogonal wave functions, significance of ψ and ψ^2, shapes of s, p, d and f orbitals, rules for filling electrons in various orbitals, effective nuclear charge, Slater's rules

Periodic Table and Atomic Properties

Classification of periodic table, definition of atomic and ionic radii, ionization energy, electron affinity and electronegativity, trends in periodic table (in s and p block elements), Pauling, Mulliken, Allred Rachow and Mulliken Jaffe's electronegativity scale.

Unit-II

Gaseous State

Kinetic theory of gases, Maxwell's distribution of velocities and energies (derivation excluded), Calculation of root mean square velocity, average velocity and most probable velocity. Collision diameter, collision frequency and mean free path (derivation excluded), Deviation of real gases from ideal gas behaviour, derivation of van der Waal's equation of state, its applications in the calculation of Boyle's temperature (compression factor), Explanation of behaviour of real gases using van der Waal's equation

Solid State

Classification of solids, Elements of symmetry and symmetry elements of crystals, definition of unit cell and space lattice, bravais lattices, crystal system, Laws of crystallography – Law of constancy of interfacial angles, law of rationality of indices and law of symmetry, Miller Indices X-ray diffraction by crystals, derivation of Bragg's law and Bragg's equation, Determination of crystal structure of NaCl and KCl.

Unit-III

General Organic Chemistry

Localized and Delocalized chemical bond, van der Waal's interactions, resonance and its conditions and applications, hyperconjugation, inductive effect, electromeric effect and their comparison

Stereochemistry of Organic Compounds

Types of isomerism, optical isomerism - elements of symmetry, molecular chirality, chiral and achiral molecules with two stereogenic centres, enantiomers and their properties, diastereomers and their properties, erythro and threo diastereomers, meso compounds,

Difference between conformations and configurations, Newmann and Sawhorse projections, Fischer and Flying wedge configurations

Conformational isomerism – conformational analysis of ethane and n-butane, conformations of cyclohexane

Relative and absolute configurations, sequence rules, R & S systems of nomenclature

Geometric isomerism – cis, trans isomerism, E & Z system of nomenclature

Unit-IV (Practical)

1. Titrimetric Analysis: (i) Calibration and use of apparatus (ii) Preparation of solutions of different concentration
2. Standardization of different solution.
3. Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$ (using $KMnO_4$ and $K_2Cr_2O_7$)
4. To determine the surface tension of a given liquid by drop number method using stalagmometer.
5. To prepare m-dinitrobenzene from nitrobenzene using nitrating mixture
6. To prepare Iodoform from acetone/ ethyl alcohol

Reference Readings:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. B. R. Puri, Madan S. Pathania, L. R. Sharma Principles of Physical Chemistry,
4. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
5. Advanced Practical Organic Chemistry, N K Vishnoi.
6. Advanced Practical Physical Chemistry, J B Yadav.
7. Advanced Practical Inorganic Chemistry, Gurdeep Raj.

Note for the Theory Paper Setter: The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus from unit 1st, 2nd and 3rd. In addition, six more questions of 14 marks each will be set unit-wise comprising of two questions from each of the three units (I, II, III). The candidates are required to attempt one compulsory question and three more questions selecting at least one question from each unit.

Note: - Unit IV only practical purpose.

BSC/CHEM/MD/1/MIC/101

Chemistry Minor - I

DURATION: 2 HOURS **MAXIMUM MARKS: 50**
Credit: 2 **Theory: 50 (External 35 + Internal 15)**

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: To learn about the nomenclature, classification and methods of preparation of alkenes.
CO2: To learn about qualitative knowledge of conductors, semiconductors and insulators.
CO2: To get the basics of rates of chemical reactions and factors affecting it.
CO3: To understand the basics of covalent bonding in simple molecules.

UNIT I

Alkanes (up to 5 carbon atoms)
Alkanes, nomenclature, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation: Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties. Mechanism of free radical halogenation of alkanes: reactivity and selectivity.

Chemical Kinetics
Concept of reaction rates, rate equation, factors influencing the rate of reaction, Order and molecularity of a reaction, integrated rate expression for zero, first, second order reactions (for equal conc. of reactants), Half-life period of a reaction.

UNIT II

Metallic Bond and semiconductors
Metallic bond – Qualitative idea of valence bond and Band theories of metallic bond (conductors, semiconductors, insulators). Semiconductors – Introduction, types, and applications

Covalent Bond
Valence bond theory approach, shapes of simple inorganic molecules and ions based on valence shell electron pair repulsion (VSEPR) theory and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Molecular orbital theory of homonuclear (N_2, O_2) and heteronuclear (CO and NO) diatomic molecules, dipole moment.

Learning Resources

1. Dhawan S. N., Organic Chemistry, Vol 1 Pardeep Publication.
2. Principles of Physical Chemistry, Puri, Sharma, Pathania.
3. Concise Inorganic Chemistry, J. D. Lee.
4. Organic Chemistry, Morrison and Voyd.

Note for the Theory Paper Setter: Five questions will be set in all. Question No. 1 will be compulsory and will consist of seven short questions of one mark each (total marks 07) covering the whole syllabus from Unit (I, II). In addition, two more questions will be set from each unit consist of fourteen marks each. The candidate will be required to attempt two more question (14 marks), in addition to compulsory Question.

BSC/BCOM/BA/CHEM/MD/1/MDC/101

Introductory Chemistry-I

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: To get knowledge about structure and bonding.
CO2: To get aware about different polymers and get knowledge about preservative.
CO3: To get knowledge about experiments related to daily life.

UNIT I

Atomic Structure Concept of Bonding (1-20)
Introduction, Elementary introduction of atomic structure, Representation of elements/ atoms, Bhor Model, Lewis's dot structure, electronic configurations, Ionization Energy, Electron Affinity Electro Negativity, Types of Bonding
Carbon and its Compounds
Introduction, Tetravalency of Carbon, allotropes of carbon and their properties, hydrocarbons (1-5), Nomenclature (linear compounds), Applications of hydrocarbons.

UNIT II

Polymers
Introduction, elementary idea of polymer, Types of polymers: Natural, synthetic, semi-synthetic Homo polymers and copolymers, uses of polymer (Natural rubber, Vulcanized rubber, Polyethene, PVC, Styrene, Teflon, PAN, Nylon-66)
Food Preservatives
Elementary idea of natural and synthetic food preservatives, rancidity, uses and properties, different food preservation processes (pickle, Jam), artificial sweeteners, uses and properties

UNIT III (Practical)

Practicals:
1. Preparation of solution of different concentration.
2. Identify the pH of the given samples through pH strip/pH meter.
3. Experiments related to persevering food items.
4. To synthesize some polymers as per available resources.

Learning Resources

1. Subbulakshmi G, Food processing and preservation, New Age International Publishers.
2. Manas Chanda, 2013, Introduction to Polymer Science and Chemistry 2nd Edition.
3. Making Rayon Fiber - Artificial silk, chemical experiment!
4. How to make silk from cotton wool ("Artificial silk" experiment).
5. Neelam Seedher, Basic Concepts: Physical Chemistry Experiments, Kindley Edition.

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of 1 mark each covering the whole syllabus from 1st and 2nd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note: - Unit III only practical purpose.

BSC/CHEM/MD/1/SEC/101

Pesticide Chemistry

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: Students will be able to learn about the preparation and uses of pesticides in everyday life.
CO2: Get the knowledge of Pesticide formulations.
CO3: Generate knowledge of Pesticide formulations and their toxicity.

UNIT I

Introduction: Classification, synthesis, structure activity relationship (SAR), mode of action, uses and adverse effects of representative pesticides in the following classes: Organochlorines (DDT, Gammaxene); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and Carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).
Botanical insecticides [No structure elucidation or synthesis is required for the following Compounds: Alkaloids (Nicotine); Pyrethrum (natural and synthetic pyrethroids); Azadirachtin; Rotenone and Limonene.

UNIT II

Pesticide Formulations: Wettable powders, Surfactants, Emulsifiable concentrates, Aerosols, Dust and Granules, Controlled Release Formulations
New Tools in Biological Pest Control: Repellants, Chemosterilants, Antifeedants.

UNIT III (Practical)

1. To carryout market survey of potent pesticides with details as follows:
   a) Name of pesticide b) Chemical name, class and structure of pesticide
   c) Useful information on label of packaging regarding: Toxicity, LD50 ("Lethal Dose, 50%"), Side effects and Antidotes.
2. To carryout market survey of potent botanical pesticides with details as follows:
   a) Chemical name (active ingredient) and structure of active ingredient
   b) Useful information on label of packaging regarding: Toxicity, LD50 ("Lethal Dose, 50%"), Side effects and Antidotes.
3. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
4. Preparation of Neem Based Botanical Pesticide

Learning Resources

1. Perry, A.S.; Yamamoto, I.; Ishaaya, I.; Perry, R. Y. (1998), **Insecticides in Agriculture and Environment**, Springer-Verlag Berlin Heidelberg.
2. Kuhr, R. J.; Derough, H. W. (1976), **Carbamate Insecticides: Chemistry, Biochemistry and Toxicology**, CRC Press, USA.

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of 1 mark each covering the whole syllabus from 1st and 2nd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note: - Unit III only practical purpose.

BSC/CHEM/MD/1/SEC/102

Fuel Chemistry

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: The course covers both conventional petroleum-based fuels, and alternative & renewable fuels, including gaseous fuels. The students will learn the chemistry that underpins petroleum fuel technology, will understand the refining processes used to produce fuels and lubricants and will know how differences in chemical composition affect properties of fuels and their usage in different applications.

CO2: The course will also cover origin of petroleum, crude oil, composition, different refining processes employed industrially to obtain different fractions of petroleum. Further, course will cover various alternative and renewable fuels like Biofuels (Different generations), Gaseous Fuels (e.g. CNG, LNG, CBG, Hydrogen etc.).

CO3: The course will also cover fuel product specifications, various test methods used to qualify different types of fuels as well characterization methods.

UNIT I

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Determination of calorific value by Bomb calorimeter and Junker's calorimeter.

Coal: Analysis of coal, Proximate and ultimate Analysis, Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas composition and uses. Fractionation of coal tar, uses of coal tar-based chemicals, requisites of a good metallurgical coke, Coal gasification (Hydrogasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

UNIT II

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

UNIT III (Practical)

1. To prepare chart of calorific value of different fuel.
2. To determine the viscosity of biodiesel at various temperature.
3. To determine free fatty acid content in given sample.
4. To determine the density of the given fuel sample.
5. Simple Test Method (Density, Filter Paper Test) of Petroleum Product.

Learning Resources

1. Stocchi, E. (1990), **Industrial Chemistry**, Vol -I, Ellis Horwood Ltd. UK.

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of 1 mark each covering the whole syllabus from 1st, 2nd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note: - Unit III only practical purpose.

SECOND SEMESTER

BSC/CHEM/MD/2/DSC/151
Chemistry-II

DURATION: 3+2 HOURS **MAXIMUM MARKS: 100**
Credit: 3+1 = 4 **Theory: 75 (External 50 + Internal 25)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: Able to understand the different theories of covalent bonding & structure of solids.
CO2: To know the basics of hydrogen bonding & chemical kinetics of reactions.
CO3: To learn about the mechanism of organic reactions with special emphasis on alkanes & cycloalkanes.
CO4: To make the students to understand about the iodometry, chromatography and physical properties of liquids.

Unit-I

Covalent Bond

Valence bond theory and its limitations, types of bonds like covalent, ionic bond and dative bonds with examples, various types of hybridization and shapes of simple inorganic molecules and ions $BeF_2, BF_3, CH_4, PF_5, SF_6, IF_7, SO_4^{2-}, ClO_4^-$.

Valence Shell Electron Pair Repulsion theory to $NH_3, H_3O^+, SF_4, ClF_3, ICl_2^-, H_2O$

MO theory of homonuclear (H_2, N_2, O_2) and heteronuclear molecules (NO, NO^+, NO^-, CO, CO^+), and calculate their bond order, magnetic character. Concept of dipole moment and % ionic character in covalent bond.

Ionic Solids

Ionic structures (NaCl, CsCl, ZnS (Zinc blende), CaF_2). Radius ratio rule and its limitations, coordination number, Concept of lattice energy (mathematical derivation excluded) and Born Haber cycle, solvation energy and its relation with solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule.

Hydrogen Bonding & van der Waal's forces

Hydrogen Bonding - Definition, types, effects of hydrogen bonding on properties of substances, applications

Discussion of various types of van der Waals interactions

Unit-II

Acid and Base

Definition of pH and pK_a, Buffer solution, Buffer action, Handerson-Hazel equation, Buffer mechanism of buffer action

Chemical Kinetics

Rate of Reaction, rate equation, factors affecting the rate of reaction – concentration, temperature, light, catalyst. Order and molecularity of a reaction, Integrated rate expressions for zero, first order, second order, half-life period of reactions, their graphical representations also, Methods of determination of order of reaction, Effect of temperature on the rate of a reaction – Arrhenius equation. Theories of reaction rate – Simple collision theory for unimolecular and bimolecular collision, transition state theory for bimolecular reactions

Unit-III

Mechanism of Organic Reactions

Curved arrow notation, drawing electron movements with arrows, homolytic and heterolytic bond fissions, types of reagents – electrophiles and nucleophiles, types of organic reactions - addition, substitution, condensation, elimination and rearrangement, pericyclic reactions.

Reaction intermediates – carbocations, carbanions, free radicals (preparation, structure and stability and reactions)

Alkanes

Classification of carbon atoms in alkanes, isomerism in alkanes, methods of preparation (with special reference to Wurtz reaction, Kolbe's electrolytic method, Corey-House reaction and decarboxylation of carboxylic acids, Sabatier and Sendern's reaction), physical properties, mechanism of halogenation of alkanes – reactivity and selectivity.

Cycloalkanes

Baeyer's ring strain theory and its limitations, theory of strainless rings.

Unit-IV (Practical)

1. **Iodometric titrations:** Determination of Cu^{2+} (using standard hypo solution)
2. To determine any one of the following cations and anions by paper chromatography: $Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}, Cl^{-}, Br^{-}, I^{-}, PO_4^{3-}, NO_3^{-}$
3. To determine the viscosity of a given liquid using Ostwald's viscometer.
4. To determine the specific refractivity of a liquid by refractometer.
5. To prepare S-Benzyl isothiouronium chloride from thiourea.
6. To separate mixture of organic compounds using common organic solvents by using TLC and determine R_f values.

Reference Readings:

1. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
2. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
3. B. R. Puri, Madan S. Pathania, L. R. Sharma Principles of Physical Chemistry, Vishal Publications.
4. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
5. Advanced Practical Organic Chemistry, N K Vishnoi.
6. Advanced Practical Physical Chemistry, J B Yadav.
7. Advanced Practical Inorganic Chemistry, Gurdeep Raj

Note for the Theory Paper Setter: The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus from 1st,2nd and 3rd unit. In addition, six more questions of 14 marks each will be set unit-wise (I, II, III) comprising of two questions from each of the three units. The candidates are required to attempt one compulsory question and three more questions selecting at least one question from each unit.

Note:- Unit IV only practical purpose.

BSC/CHEM/MD/2/MIC/151

Chemistry Minor -II

DURATION: 2 HOURS **MAXIMUM MARKS: 50**
Credit: 2 **Theory: 50 (External 35 + Internal 15)**

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: To know the basics of periodic properties and hybridization and the ionic solids.
CO2: Understand about the semiconductors and metallic bonds.
CO3: Get the knowledge of stereochemistry of simple organic molecules

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UNIT I

Periodic Table and Atomic Properties

Atomic properties: atomic and ionic radii, ionisation energy, electron affinity and electronegativity definition, methods of determination or evaluation, trend in periodic table, effective nuclear charge, Slater's rules. Directional characteristics of covalent bond, various type of hybridisation and shapes of simple inorganic molecules and ions $BeF_2, BF_3, CH_4, PF_5, SF_6, IF_7, SO_4^{2-}, ClO_4^{-1}$

Ionic Solids and Semiconductors:

Stoichiometric and non-stoichiometric defects in crystals, Lattice energy and Born- Haber cycle, Solvation energy and its relationship with solubility of Ionic solids, Polarizing power and Polarisability of ions, Fajan's rule. Metallic bond – Qualitative idea of valence bond and Band theories of metallic bond (conductors, semiconductors, insulators) Semiconductors – Introduction, types, and applications.

UNIT II

Bonding & Structure of Organic Compounds

Structure and Bonding in Organic Compounds, Localized and delocalized chemical bond, Van der Waal's interactions, Resonance: conditions, resonance effect and its applications, hyperconjugation, inductive effect, Electromeric effect & their comparison.

Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism. Optical isomerism, element s of symmetry, enantiomers, stereo genic centre, optical activity, properties of enantiomers, chiral and achiral molecules (upto two stereo genic centres), diastereomers, threo and erythro diastereomers, meso compounds Relative and absolute configuration, sequence rules, R & S systems of nomenclature. Geometrical isomerism. Determination of configuration of geometric isomers.

Learning Resources

1. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009),
2. Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
3. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.
4. Kapoor, K. L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
5. Nasipuri, D. (2018), Stereochemistry of Organic Compounds: Principles and Applications, 3rd Edition, New Age International.
6. Gunstone, F. D. (1975), Guidebook to Stereochemistry, Prentice Hall Press.

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Note for the Theory Paper Setter: Five questions will be set in all. Question No. 1 will be compulsory and will consist of seven short questions of one mark each (total marks 07) covering the whole syllabus. In addition, two more questions will be set from each unit consist of fourteen marks each. The candidate will be required to attempt two more question (14 marks), in addition to compulsory Question.

BSC/BCOM/BA/CHEM/MD/2/MDC/151

Introductory Chemistry -II

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: To learn about role of Indian scientists in the upliftment of research and classification of elements with their properties.

CO2: To learn about three states of matter and more knowledge about role of fertilizers in fertility of soil.

CO3: To learn about reaction in daily life**.**

UNIT I

Renowned Indian Scientists

Brief Biography of Renowned Indian Scientists (Hargobind Khurana, Dr. P. C, Ray, Sir C.V. Raman, Dr. A.P.J. Abdul Kalam, Dr. Vikram Sara Bhai, Dr. Homi Jahangir Bhabha, Dr. J.C. Bose)

Metal and Non-Metals

Periodic table, classification of elements, physical and chemical aspects of metals and non-metals, Ore and Minerals of Iron, Copper, Aluminum, alloys.

UNIT II

Physical Properties of Matter

Classification of matter, properties, uses, ideal gas equation, real gas equation, some important compounds (baking soda, washing soda, plaster of Paris, gypsum, glass)

Soil and fertilizers

Green revolution, soil: types of soil and their components for fertility, grow condition, pH, irrigation, biofertilizers, chemical fertilizers and their uses, acid rain

UNIT III (Practical)

1. To prepare Plaster of Paris.
2. To prepare Potash Alum.
3. To study the effect of acid on Baking and washing soda.
4. To perform the action of water on quick lime and identify the nature of reaction (Exo/Endothermic).

Learning Resources

1. Chemistry In Daily Life: Third Edition by Kirpal Singh, PHI Learning.
2. General Chemistry: Principles, Patterns, and Applications, Bruce Averill, Strategic Energy.
3. Security Solution, Patricia Eldredge, R.H. Hand, LLC, Copyright Year: 2011.
4. The Great Indian Scientists Paperback – 1 January 2017, Cengage Learning India.

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of one mark each covering the whole syllabus from 1st and 2nd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note:- Unit III only practical purpose.

BSC/CHEM/MD/2/SEC/151

Basic Analytical Chemistry

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: Handle analytical data and pH of soil.
CO2: Do quantitative analysis of metal ions in water, Separate mixtures using separation techniques.
CO3: Determine composition, which can be useful in agriculture.

UNIT I

Introduction to analytical chemistry and its interdisciplinary nature, Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Significant figures. Presentation of experimental data and results.
Composition of soil, concept of pH and its measurement, complexometric titrations, chelation, chelating agents, use of indicators

UNIT II

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods
Chromatography
Definition and general introduction on principles of chromatography. Paper chromatography, thin layer chromatography, Column chromatography and ion-exchange chromatography.

UNIT III (Practical)

1. Determination of pH of soil samples by pH meter.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample by pH meter.
4. To study the use of phenolphthalein.
5. Determination of dissolved oxygen of water samples.

Learning Resources

1. Christian, G.D. (2004), Analytical Chemistry, John Wiley & Sons.
2. Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.
3. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd.
4. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis, Prentice Hall.
5. Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), Vogel's Quantitative Chemical Analysis,6th Edition, Prentice Hall.

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of one mark each covering the whole syllabus from 1st and IInd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note: - Unit III only practical purpose.

BSC/CHEM/MD/2/SEC/152

Green Methods in Chemistry

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: Get idea of toxicology, environmental law, energy and the environment, think to design and develop materials and processes that reduce the use and generation of hazardous substances in industry.

CO2: Get ideas of innovative approaches to environmental and societal challenges. Know how chemicals can have an adverse/potentially damaging effect on human and vegetation.

CO3: Think of chemical methods for recovering metals from used electronics materials. Critically analyze the existing traditional chemical pathways and processes and creatively think about. bringing environmentally benign reformations in these protocols. Convert biomass into valuable chemicals through green technologies

UNIT I

Introduction to Green Chemistry

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

1. Need of green chemistry
2. Importance of green chemistry in- daily life, Industries and solving human health problems.
3. A brief study of methods of preparation in green chemistry of any two.

UNIT II

Twelve Principles of Green Chemistry

The twelve principles of the Green Chemistry with their explanations.

Special emphasis on the following:

1. Prevention of waste / byproducts, pollution prevention hierarchy.
2. Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.
3. Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
4. Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
5. Green matrix to assess Greemess of reaction: Environmental impact factor, atom economic and calculation atom economic.

UNIT III

The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.

Designing of environmentally safe marine antifoulant. Right fit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Learning Resources

1. Anastas, P.T.; Warner, J.C. (1998), Green Chemistry, Theory and Practice, Oxford University Press.
2. Lancaster, M. (2016), Green Chemistry: An Introductory Text. 2nd Edition, RSC Publishing.

3. Cann, M. C.; Umile, T.P. (2008), Real world cases in green chemistry Vol 11, American chemical Society, Washington.
4. Matlack, A. S. (2001), Introduction to Green Chemistry, Marcel Dekker.
5. Ryan, M.A.; Tinnesand, M. (2002), Introduction to Green Chemistry (Ed), American Chemical Society, Washington DC.

Note for the Theory Paper Setter: The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions of 14 marks each will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

THIRD SEMESTER

BSC/CHEM/MD/3/DSC/201

Chemistry - III

DURATION: 3+2 HOURS **MAXIMUM MARKS: 100**

Credit: 3+1 = 4 **Theory: 75 (External 50 + Internal 25)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: Enable to understand the chemistry of p-block elements.

CO2: To learn about the electrochemistry and thermodynamics of reactions.

CO3: Get knowledge about the Huckel's rule, Markownikoff's rule and various properties and mechanism of alkenes & alkyl halides.

CO4: To make students to understand the colorimetry, determination of CST, enthalpy, solubility & preparation of some inorganic compounds.

Unit-I

p-block elements

Electronic configuration, atomic and ionic size, metallic character, melting point, ionization energy, electron affinity, oxidation states, electronegativity, inert pair effect and diagonal relationship of 13, 14, 15, 16 & 17 group

Boron family (13th group):

Diborane: Preparation, properties, and structure (as an example of electron deficient compound and multicentre bonding), Borazine- chemical properties and structure, relative strength of Trihalides of Boron as Lewis acids, structure of aluminium (III) chloride

Carbon family (14th):

Catenation, Carbides, silicates (structural aspects)

Nitrogen family (15th group):

Oxides: Structure of oxides of nitrogen and phosphorus, Oxyacid: Structure and relative acidic strength of oxyacids of nitrogen and phosphorus, structure of white, black and red phosphorus

Oxygen family (16th group):

Oxy acids of sulphur – structure and acidic strength, Hydrogen Peroxide – properties and uses

Halogen family (17th group):

Interhalogen compounds (their properties and structures), oxy acids of chlorine – structure and comparison of acidic strength

Unit-II

Electrochemistry-I

Electrolytic conduction, factors affecting electrolytic conduction, specific conductance, molar conductance, equivalent conductance and relation among them, their variation with concentration, Arrhenious theory of ionization, Ostwald's dilution law, Kohlrausch's law and its applications in calculation of conductance of weak electrolytes at infinite dilution (numerical), Applications of conductivity measurements : determination of degree of dissociation, determination of solubility product of sparingly soluble salts.

Definition of pH and pK_a, Buffer solution, Buffer action, Handerson-Hazel equation, Buffer mechanism of buffer action

Thermodynamics-I

Definition of thermodynamic terms: system, surroundings. Types of system, intensive and extensive properties, state and path functions and their differentials, Thermodynamic process, concept of heat and work, Zeroth law of thermodynamics, First law of thermodynamics, concepts of internal energy and enthalpy, heat capacity, heat capacities at constant volume and pressure and their relationship. Calculation of w, q, dU and dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Temperature dependence of enthalpy, Bond energies and applications of bond energies, Carnot cycle and its efficiency, Carnot's theorem

Unit-III

Alkenes

Structure and bonding in akenes, Methods of preparation – 1. dehydration of alcohols (with mechanism), Regioselectivity in dehydration: Saytzeff's rule and Hoffmann rule 2. dehydrohalogenation of alkyl halides. Physical properties and relative stabilities of alkenes, Chemical Reactions: hydrogenation (without mechanism), electrophilic addition reactions with examples (with mechanism), Markownikoff's rule, oxymercuration-demercuration, hydroboration oxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$

Arenes & Aromaticity

Aromaticity: Huckel's rule, concept of Aromatic, non-aromatic and antiaromatic compounds, Applications of Huckel's rule in Aromatic ions and compounds.

Structure of Benzene, Aromatic electrophilic substitution- general pattern of the mechanism, Mechanism of nitration, sulphonation, Friedel-Crafts reaction, Activating and deactivating substituents and orientation.

Alkyl Halides

Methods of preparation- from alkenes and alcohols, physical properties, nucleophilic substitution reactions of alkyl halides, SN_1 and SN_2 reactions (mechanism) with energy profile diagrams. Concept of racemisation, inversion and retention

Unit-IV (Practical)

1. **Colorimetry:** To verify Beer - Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4/K_2Cr_2O_7$ solution.
2. **Preparations:** Preparation of Cuprous chloride, tetra ammine cupric sulphate, chrome alum, potassium trioxalatochromate (III) and Nickel Hexammine chloride.
3. To determine the Critical Solution Temperature of phenol – water system.
4. To determine the solubility of benzoic acid at various temperatures and to determine the ΔH of the dissolution process.
5. To determine the enthalpy of neutralisation of a weak acid/weak base vs. strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
6. To determine the enthalpy of solution of solid calcium chloride.
7. To study the distribution of Benzoic Acid between Benzene and water.
8. Determine rate constant of hydrolysis of ethyl acetate.

Reference Readings:

1. R Chand, Organic Chemistry, Volume I & II.
2. Pradeep's Inorganic chemistry, Volume I.
3. R Chand, Inorganic chemistry, Volume I.
4. Modern Publications, Inorganic Chemistry, Volume I.
5. B. R. Puri, Madan S. Pathania, L. R. Sharma Principles of Physical Chemistry, Vishal Publications.
6. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. Advanced Practical Organic Chemistry, N K Vishnoi.
8. Advanced Practical Physical Chemistry, J B Yadav.
9. Advanced Practical Inorganic Chemistry, Gurdeep Raj.

Note for the Theory Paper Setter: The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus from unit 1st, 2nd and 3rd. In addition, six more questions of 14 marks each will be set unit-wise comprising of two questions from each of the three units (I, II, III). The candidates are required to attempt one compulsory question and three more questions selecting at least one question from each unit.

Note: - U**nit IV only practical purpose.**

BSC/CHEM/MD/3/MIC/201

Chemistry Minor - III

DURATION: 3+2 HOURS **MAXIMUM MARKS: 100**
Credit: 3+1 = 4 **Theory: 75 (External 50 + Internal 25)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: Explain the concepts of different types of solutions-miscible, partially miscible and immiscible along with their applications.
CO2: Explain the factors that affect conductance, migration of ions and application of conductance measurement
CO3: Explain the concept of electrodes and EMF.
CO4: Conduct the conductometric titrations.

UNIT I

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law- nonideal solutions. Vapour pressure, composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions, Lever rule, Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids: principle of steam distillation, Nernst distribution law and its applications, solvent extraction.

UNIT II

Conductivity

Equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions, transference number and its experimental determination using Hittorf and moving boundary methods, Ionic mobility, applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

UNIT III

Electrochemistry

Reversible and irreversible cells, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, standard electrode potential, electrochemical series. thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data, concentration cells with transference and without transference, liquid junction potential and salt bridge, pH determination using hydrogen electrode and quinhydrone electrode, Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

UNIT IV (Practical)

1. Determination of cell constant.
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations: Strong acid vs strong base.
4. Perform the following conductometric titrations: Weak acid vs strong base.
5. Perform the potentiometric titrations of Strong acid vs strong base.
6. Perform the potentiometric titrations of Weak acid vs strong base.

Learning Resources

1. Castellan, G.W. (2004), Physical Chemistry, Narosa.
2. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
3. Kapoor, K.L. (2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, (2017), Principles of Physical Chemistry, Vishal Publishing Co.
5. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

6. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co.
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
9. Mann, F.G.; Saunders, B.C. (2009), Practical Organic Chemistry, Pearson Education.

Note for the Theory Paper Setter: The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus from unit 1st, 2nd and 3rd. In addition, six more questions of 14 marks each will be set unit-wise comprising of two questions from each of the three units (I, II, III). The candidates are required to attempt one compulsory question and three more questions selecting at least one question from each unit.

Note: - Unit IV only practical purpose

BSC/BCOM/BA/CHEM/MD/3/MDC/201

Introductory Chemistry-III

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: To learn about different Pollution and Energy: Energy sources.
CO2: To learn about the purification process of water quality and Pesticides and their bad impacts on health.
CO3: To learn about different methods for water analysis.

UNIT I

Pollution and their types: Plastic and polyethene pollution, pollution sources, Recycling of plastic, greenhouse effect, ozone depletion.
Energy: Energy sources, renewable and non-renewable sources, cells and batteries, fuel cell, solar cell, polymer cell.

UNIT II

Water: Sources of drinking water and uses, water conservation, Permissible TDS, Techniques of purification of water, R.O. water purification process (Osmosis and Reverse Osmosis).
Pesticides and Herbicides: General introduction and definition, biological control and chemical control: natural and synthetic pesticides, benefits and adverse effects of DDT, BHC (without Structure) malathion.

UNIT III (Practical)

1. To check the TDS of different samples of water.
2. Purify the given sample of water using different purification techniques.
3. Identify the pH of different samples of food items.
4. Neutralize the given samples of base using acids.

Learning Resources

1. Zero Waste: Management Practices for Environmental Sustainability by Ashok K. Rathore.
2. Sustainable Solid Waste Management by Ni-Bin Chang.
3. Handbook of Advanced Industrial and Hazardous Wastes Treatment by Lawrence, K. Wang (Editor); Nazih K. Shammas (Editor); Yung Tse Hung (Editor.)
4. Pesticides and Insecticides, Development and Use, Bobby Jones|2018.
5. Water Treatment, How to Make Water Safe to Drink, David Holman.
6. Energy, A Beginner's Guide, Vaclav Smil,2017.
7. Advanced Physical Chemistry, Practical Handbook, Gurdeep Raj, Edition (2016).
8. Advanced Practical Physical Chemistry, Handbook, J. B. Yadav, Edition (2016).

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of one mark each covering the whole syllabus from 1st and 2nd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note:- Unit III only practical purpose.

BSC/CHEM/MD/3/SEC/201

Chemistry of Cosmetics & Perfumes

DURATION: 2+2 HOURS **MAXIMUM MARKS: 75**
Credit: 2+1 = 3 **Theory: 50 (External 35 + Internal 15)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:
CO1: Learn basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products.
CO2: Learn the use of safe, economic and body-friendly cosmetics.
CO3: Prepare new innovative formulations.

UNIT I

Cosmetics- Definition, History, Classification, Ingredients, Nomenclature, Regulations.

Face Preparation: Structure of skin, Face powder, Compact powder, Talcum powder.

Skin Preparation: Face cream, vanishing cream, cold cream, suntan cream, lather shaving cream.

UNIT II

Hair preparation: Structure of hair, classification of hair, Hair dye- classification – temporary, semipermanent, permanent, formulation, hair sprays, shampoo- types of shampoo, conditioners
Colored preparation: Nail preparation Structure of nail, Nail lacquers, Nail polish remover Lipsticks

Personal hygiene products: Antiperspirants and deodorants, oral hygiene products, flavours and essential oils

UNIT III (Practical)

Preparation of the following:

1. Talcum powder.
2. Shampoo.
3. Face cream.
4. Nail polish and nail polish remover.
5. Hand wash
6. Hand sanitizer
7. Body lotion
8. Soap
9. Tooth powder
10. Tooth paste

Learning Resources

1. Barel, A.O.; Paye, M.; Maibach, H. I. (2014), Handbook of Cosmetic Science and Technology, CRC Press.
2. Garud, A.; Sharma, P.K.; Garud, N. (2012), Text Book of Cosmetics, Pragati Prakashan.
3. Gupta, P.K.; Gupta, S. K. (2011), Pharmaceutics and Cosmetics, Pragati Prakasha
4. Butler, H. (2000), Poucher's Perfumes, Cosmetic and Soap, Springer
5. Kumari, R. (2018), Chemistry of Cosmetics, Prestige Publisher.

Note for the Theory Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of one mark each covering the whole syllabus from 1st and 2nd unit. In addition, four more questions of 14 marks each will be set unit-wise (I, II) comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting at least one question from each unit.

Note:- Unit III only practical purpose.

FOURTH SEMESTER

BSC/CHEM/MD/4/DSC/351

Chemistry - IV

DURATION: 3+2 HOURS **MAXIMUM MARKS: 100**

Credit: 3+1 = 3 **Theory: 75 (External 50 + Internal 25)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: Enable to understand the chemistry of d-block elements & co-ordination compounds.

CO2: To learn about the electrochemistry and thermodynamics of reactions.

CO3: Get knowledge about the various properties and mechanism of alcohols, phenols & carbonyl compounds.

CO4: To make students to understand the synthesis of organic compounds & qualitative analysis of radicals.

Unit-I

Chemistry of d-block elements

Definition of transition elements, position in the periodic table, General characteristic properties of d-Block elements, Comparison of properties of 3d elements with 4d and 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties, and stereochemistry. Stability of various oxidation states, Structure and properties of some compounds of transition elements- $Ni(CO)_4, CuCl_2, VOCl_2, TiO_2, FeCl_3$

Coordination Compounds

Werner's theory of coordination compounds, effective atomic number, chelates, nomenclature of coordination compounds, Isomerism in coordination compounds, valence bond theory of transition metal complexes.

Unit-II

Thermodynamics-II

Second law of thermodynamics, concept of entropy, entropy as a function of Volume & Temperature, entropy as a function of Pressure & Temperature, entropy as a criterion of spontaneity and equilibrium. Entropy changes in ideal gases and mixing of gases.

Gibbs and Helmholtz functions: Gibbs function (G), and Helmholtz function (A) as a thermodynamic quantity, G & A as criteria for thermodynamic equilibrium and spontaneity, variation of G and A with P & V, Van't Hoff reaction isotherm

Electrochemistry-II

Conventional representation of electrochemical cells, EMF of a cell and its measurement, Weston standard cell, activity, Calculation of thermodynamic quantities of cell reaction (ΔG, ΔH, K)

Electrode reactions, Nernst equations, derivation of cell EMF and single electrode potential, Standard Hydrogen Electrode, reference electrodes, standard electrode potentials, sign conventions, electrochemical series and its applications.

Unit-III

Alcohols

Monohydric alcohols: methods of formation: by reduction of aldehydes, ketones, carboxylic acids, and esters. Hydrogen bonding, Acidic nature, Reactions of alcohols.
Dihydric alcohols —methods of formation, chemical reactions of vicinal glycols, oxidative cleavage by using [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

Phenols

Structure and bonding, Preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols — electrophilic aromatic substitution, Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction

Aldehydes and Ketones

Structure of aldehydes and ketones, Methods of preparation: aldehydes from acid chlorides and from nitriles, advantage of oxidation of alcohols, comparison of reactivity of aldehydes and ketones, Mechanism of nucleophilic additions to carbonyl compounds with particular emphasis on Aldol, Benzoin, Perkin condensations. Wittig reaction, Mannich Reaction, MPV, Clemmensen and Wolff-Kishner reductions.

Unit-IV (Practical)

1. To prepare m-nitroaniline from m-dinitrobenzene.
2. To prepare p-nitroacetanilide from acetanilide.
3. Semimicro qualitative analysis of mixture containing not more than four radicals (excluding interfering, Combinations and insoluble): (at least 4 experiments)

$Pb^{2+}, Hg^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Hg_2^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+},$
$Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^{+}, CO_3^{2-}, S^{2-}, SO_3^{2-}, S_2O_3^{2-}, NO_2^{-}, CH_3COO^{-},$
$Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, SO_4^{2-}, C_2O_4^{2-}, PO_4^{3-}, BO_3^{3-}$

Reference Readings:

1. Modern Publications, Organic Chemistry, Volume I & II.
2. Pradeep's Inorganic chemistry, Volume I.
3. R Chand, Inorganic chemistry, Volume I.
4. Modern Publications, Inorganic Chemistry, Volume I.
5. B. R. Puri, Madan S. Pathania, L. R. Sharma Principles of Physical Chemistry, Vishal Publications.
6. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. Advanced Practical Organic Chemistry, N K Vishnoi.
8. Advanced Practical Physical Chemistry, J B Yadav.
9. Advanced Practical Inorganic Chemistry, Gurdeep Raj.

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Note:- **Unit IV only practical purpose.**

BSC/CHEM/MD/4/MIC/251

Chemistry Minor - IV

DURATION: 3+2 HOURS **MAXIMUM MARKS: 100**

Credit: 3+1 = 4 **Theory: 75 (External 50 + Internal 25)**

Practical: 25

Course Outcomes (CO): After completing the course, the student shall be able to:

CO1: Understand the metals and non-metals

CO2: Understand the solid state and liquid state property

CO3: Explain the concept Kinetic Theory of Gases

CO4: Can measure the viscosity and surface tension

UNIT I

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy with reference to cyanide process for silver and gold, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Van Arkel-De Boer process, Mond's process and Zone Refining.

UNIT II

Solids

Forms of solids, symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of crystallography - law of constancy of interfacial angles. Law of rational indices, Miller indices. X–ray diffraction by crystals, Bragg's law, structures of NaCl, KCl and CsCl (qualitative treatment only), defects in crystals. Glasses and liquid crystals.

Liquids

Surface tension and its determination using stalagmometer, Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer, effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

UNIT III

Kinetic Theory of Gases

Postulates of kinetic theory of gases and derivation of the kinetic gas equation, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation, van der Waals equation of state for real gases. Boyle temperature (derivation not required), critical phenomena, critical constants and their calculation from van der Waals equation, Andrew's isotherms of CO_2, Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions, most probable, average and root mean square velocities (no derivation), collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules, viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

UNIT IV (Practical)

1. Semi-micro qualitative analysis of mixtures using H_2S or any other scheme- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:
   Cations: $NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}$
   Anions: $CO_3^{2-}, S^{2-}, SO_3^-, NO_2^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, C_2O_4^{2-}, F^-$.
   (Spot tests should be carried out wherever feasible)
2. Surface tension measurement (use of organic solvents excluded):
   Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
3. Viscometer. (use of organic solvents excluded):
   a) determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald Viscometer.
   b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
4. Study the kinetics of the following reactions by integrated rate method:
   a) Acid hydrolysis of methyl acetate with hydrochloric acid.
   b) Compare the strength of *HCl* and H_2SO_4 by studying the kinetics of hydrolysis methyl acetate.

Learning Resources

1. Lee., J. D. (2010), A new Concise Inorganic Chemistry, Pearson Education.
2. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkin's Inorganic Chemistry, Oxford.
3. Miessler, G. L.; Tarr, D. A. (2014), Inorganic Chemistry, Pearson.

4. Castellan, G. W. (2004), Physical Chemistry, Narosa.
5. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.1, 6th Edition, McGraw Hill Education.
6. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.5, 3rd Edition, McGraw Hill Education.
7. B. R. Puri, L. R. Sharma, M. S. Pathania, (2017), Principles of Physical Chemistry, Vishal Publications.
8. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis, Prentice Hall.
9. Khosla, B.D.; Garg, V. C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co.

Note for the Theory Paper Setter: The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus from unit 1st, 2nd and 3rd. In addition, six more questions of 14 marks each will be set unit-wise comprising of two questions from each of the three units (I, II, III). The candidates are required to attempt one compulsory question and three more questions selecting at least one question from each unit.

Note:- Unit IV only practical purpose.