

Curriculum Framework
Syllabus – B.Sc. (Chemistry) 2022-23
L-5 (I Semester)

I-Semester									
Level / Semester	Nature of Course	Courses Code	Course Title	MM	L	T	P	C	
L-5 I Semester	Discipline Specific: Major	CHE-DSM-111	Fundamentals of Inorganic & Physical Chemistry (Theory)	100	4	0	0	4	
	Discipline Specific: Major	CHE-DSM-112	Inorganic & Physical Chemistry (Practical)	100	0	0	2	2	
	Discipline Specific: Major	DSM-113	Other Department	100	6	0	0	6	
	Multi Discipline Major	CHE-MDM-111	Chemical Biology (Theory)	100	4	0	0	4	
	Discipline Specific: Major	CHE-MDM-112	Chemical Biology (Practical)	100	0	0	2	2	
	Skill Enhancement Course (Either in I or II Sem)	CHE-SEC-111	Basic Laboratory Practices	100	0	0	2	2	
	Value Enhancement Course	VEC-111	Other Department						Qualifying
	Total Credits								20

Form 10	
Note: Student can choose either AEC or SEC in one semester	
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Bachelor of Science – B.Sc. Disciplinary Major (DSM) B.Sc. I Semester CHE-DSM-111: Fundamentals of Inorganic & Physical Chemistry (Theory)		
Credit: 04	Time: 60 Hrs	
Course Objective: 1. To impart basic knowledge of atomic and molecular structure among the students. 2. To strengthen fundamental concepts of equilibrium and energetic in Physical Chemistry.		
Unit wise Learning Outcomes: 1. To predict the atomic structure and learn the scientific theory of atoms, the concept of the wave function and the position of the electron in the atom. 2. Elements in the periodic table, physical and chemical characteristics, periodicity. 3. Characteristic bonding between atoms and molecules 4. To understand the concept of rate of change associated with chemical change 5. Ionic equilibria- electrolytes, ionization, dissociation and to explain thermodynamic properties and calculate entropy of the system		
Unit I	Atomic Structure: History of atomic structure, Bohr's theory and its limitations, dual 2nergetic of matter and radiation, de- Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to atomic structure. Quantum mechanics: Introduction to Quantum mechanics. Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogen wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers: Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s . Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).	12
Unit II	Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations, Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P. Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.	12
Unit III	Chemical Bonding and Molecular Structure: Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and 2nergetic energy and their importance in the	12

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19/04/2022

	context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. Weak Chemical Forces: Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, Hydrogen bonding, Effects of weak chemical forces, melting and boiling points, solubility, Energetic of dissolution process.	
Unit IV	Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG°, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.	12
Unit V	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. Laws of Thermodynamics: Review of thermodynamics; Statement of Third Law of thermodynamics and calculation of absolute entropies of substances. Chemical Energetics: 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.	12

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References

Essential readings:

1. W. J. Huheey, Inorganic Chemistry: Principles of structure and Reactivity, Fourth Edition, Pearson.
2. B.R. Puri, L.R. Sharma, K.C. Kalia, Principle of Inorganic Chemistry, 33rd edition, Vishal Publishing Co.
3. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, John-Wiley & Sons.
4. Douglas, McDaniel and Alexander: Concepts and Models in Inorganic Chemistry, John Wiley.
5. Quantum Chemistry, 1st Indian Edition 2003, D. A. McQuarrie, Viva Books Pvt. Ltd
6. R.A. Alberty, Physical Chemistry, 4th Edition, John-Wiley & Sons.
7. C.N.R Rao, University General Chemistry, 1st Edition, MacMillan India Ltd- New Delhi.
8. P.W. Atkins & J.D. Paula, Elements of Physical Chemistry, Seventh Edition, Oxford University Press.
9. G. M. Barrow, Physical Chemistry, 5th Edition, Tata McGraw Hill (2007).
10. K.L. Kapoor, A Textbook of Physical Chemistry, Vol. 3, 3rd Edition, McMillan.

Important Web-links:

1. <https://ocw.mit.edu/courses/5-111-principles-of-chemical-science-fall-2008/>
2. <https://ocw.mit.edu/courses/5-112-principles-of-chemical-science-fall-2005/>
3. Massive Open Online Course on Chemical Thermodynamics and Chemical Kinetics by Prof. Arijit Kumar De, IISER Mohali, https://onlinecourses.nptel.ac.in/noc22_cy58/preview
4. Massive Open Online Course on Quantum Chemistry of Atoms and Molecules by Prof. Anindya Datta, IIT Bombay, https://onlinecourses.nptel.ac.in/noc22_cy41/preview

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Bachelor of Science – B.Sc.

Disciplinary Major (DSM)

B.Sc. I Semester

CHE-DSM-112: Inorganic & Physical Chemistry (Practical)

Credit: 02

Time: 30 Hrs

Course Learning objective: To provide basic concepts of apparatus and chemical handling and to introduce some practical methodologies

Learning Outcomes:

- To make the student understand about the use of different apparatus and how to calibrate them.
- The student will learn to prepare different types of standard solutions.
- Differentiation between primary and secondary standards.
- Quantification of analytes by volumetric analysis.
- The student will understand the concept of density, surface tension, viscosity and will learn how to measure it.

Laboratory course

- Calibration and use of apparatus

Volumetric analysis (Inorganic)

- Preparation of standard solution solid/liquid.
- Preparation of solution of different molarity/normality of titrants.
- Standardization of secondary standard; Acid/base/oxidizing agents.
- Estimation of carbonate and bicarbonate present together in mixture.
- Estimation of carbonate and hydroxide present together in mixture.
- To estimate Fe^{2+} and Fe^{3+} ions present in the mixture.
- To determine the strength of CuSO_4 solution iodometrically.
- To determine the total permanent & temporary hardness of water by EDTA.

Physical

- To determine the density of a given liquid by viscometer; R.D. bottle.
- Determine the surface tension by drop number method.
- Study the relative surface tension of a liquid with respect to water at room temperature by stalagmometer.
- Determination of viscosity of aqueous solution of solids/liquids at room temperature.
- Study the relative viscosity of a liquid with respect to water at room temperature by Ostwald's viscometer.

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References

1. G. Svehala and I.B. Sivankar, Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 6th Edition, 2012.
2. J. Mendham Vogel's Quantitative Chemical analysis, A.I. Vogel, Prentice Hall, 6th Edition, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
5. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.*; W.H. Freeman & Co.: New York (2003).
6. Athawale V. D. and Mathur P. *Experimental Physical Chemistry*, New Age International (2001)

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Bachelor of Science – B.Sc.
Multidisciplinary Major (MDM)
B.Sc. I Semester
CHE-MDM-111: Chemical Biology

Credits: 04

Time: 60 Hrs

Learning Objectives: To provide basic chemical understanding about biomolecules

Unit wise Learning Outcomes:

1. To learn about chemical structure and metabolism of carbohydrates
2. To learn about classification and biological importance of proteins.
3. To introduce about biological role of enzymes, and their significances.
4. To learn chemistry of steroids and lipids as well as their biological functions
5. To introduce vitamins, and basic structural understanding of DNA/RNA

Unit I	Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.	12
Unit II	Proteins: Classification, biological importance; Primary, secondary and tertiary structures of proteins: α - helix and β - pleated sheets, Metabolic products of proteins; Denaturation of proteins.	12
Unit III	Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Biocatalysis in Green Chemistry and Chemical Industry	12
Unit IV	Lipids: Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Steroids: General introductions of steroid, Hormones and Prostaglandins	12
Unit V	Vitamins: Introduction of vitamins. Classification. Water soluble vitamins (Vit-B1, B2, B3, B5, B6, B7, B9, B12 & Vit-C). Fat soluble vitamins (Vit-A, D, E & K). Function, Deficiency & toxicity of vitamins. Structure of DNA/RNA: Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.	12

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References

1. Kaim W, Bioinorganic Chemistry, Vol 4, Brigitte Schwederski, Wiley, 1994.
2. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
3. Berg J. M., Tymoczko J. L., Stryer I. Biochemistry, W. H. Freeman, 2008.
4. Bertini, I., Gray, H. B., Lippard, S. J. and Valentine, J. S. (1994)
Bioinorganic Chemistry. University Science Books (1994)
5. Lippard S., Berg J. M. Principles of Bioinorganic Chemistry; University Science Books 1994.

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Bachelor of Science – B.Sc.
Multidisciplinary Major (MDM)
B.Sc. I Semester
CHE-MDM-112: Chemical Biology (Practical)

Credits: 02

Time: 30 Hrs

Course Objective: To provide some of the practical applications and procedures involved in the experiment of Chemical Biology.

Learning Outcomes:

- To learn about estimation of carbohydrates
- To learn about isolation, estimation of proteins
- To estimate and isolate enzymes
- To estimate Lipids and fats
- To analyze vitamins, Glucose and Cholesterol

Exercises

- Isolation of proteins, Proteins – qualitative, Identification Determination of protein by the Biuret reaction. Determine the concentration of the unknown sample.
- Carbohydrates – qualitative testing and quantitative estimation of Sugars (Glucose, lactose, starch)), Estimation of Reducing. Non-reducing and total sugar contents.
- Study of the activity of Trypsin using tissue extracts.
- Effect of temperature, organic solvents, on semi-permeable membrane.
- Testing of adulterant in food, oils and vegetables.
- Determination of Ash content of a Food Sample.
- Microbial examination of Milk (Methylene blue test).
- Vitamin-C/Ascorbic acid estimation.
- Lipid & Fats: Estimation of acid value, iodine value, Saponification value of fats,
- Estimation of blood Glucose,
- Estimation of serum cholesterol.

References

1. K Wilson and J Walker, Principles and Techniques of Practical Biochemistry, 5th Ed. Oxford University Press, 2000.
2. S. Sadasivan and K Manikam, Biochemical Methods, 3rd Ed. New Age International (P) Ltd., 2007.

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**Bachelor of Science – B.Sc.
Skill Enhancement Course (SEC)
B.Sc. I Semester**

CHE-SEC-111: Basic Laboratory Practices

Credits: 02

Time: 30 Hrs

Course Objective: To provide basic knowledge behind chemical analysis

Unit wise learning outcomes:

1. The objective of the content is to make the student understand about different ways of expressing the concentration.
2. Basic understanding of the laboratory glasswares.
3. Principles of qualitative inorganic analysis and classical separation methods.
4. Basic understanding of Volumetric analysis.
5. Handling statistical data.

Unit I	Method of expressing concentration: weight percentage, mole concept, molality, molarity, normality, mole fraction, ppm and ppb, oxidation number and valency- equivalent mass conversion between units	6
Unit II	Laboratory Operations: Laboratory Safety & first aid. Use of different glasswares like pipette, burette, standard measuring flask, distillation apparatus, filtration techniques, weighing in electronic balance. Fundamental concept of primary and secondary standards quantitative dilutions and problems	6
Unit III	Qualitative analysis: Concept of solubility and solubility of inorganic and organic compounds, application of solubility product and common ion effect in the precipitation of cations. Separation and Purification Techniques: Filtration, crystallization, precipitation, Distillation (Different Types), solvent extraction	6
Unit IV	Titrimetric Analysis: Fundamental concept, primary and secondary standards quantitative dilutions and problems. Acid – Base titrations, titration curve – pH indicators. Redox titrations - titrations involving MnO_4^- , $\text{Cr}_2\text{O}_7^{2-}$, redox indicators. Complexometric titrations- EDTA titrations- Titration Curves, metal ion indicators	6
Unit V	Evaluation of Analytical Data: Units, significant digits, rounding off. Precision and Accuracy- types of errors - ways to reduce systematic errors - reporting analytical data, statistical treatment of analytical data	6

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References:

1. F.J. Welcher-Standard methods of analysis,
2. A.I. Vogel-A text book of quantitative Inorganic analysis-ELBS,
3. H.H. Willard and H. Deal- Advanced quantitative analysis- Van Nostrand Co,
4. F.D. Snell & F.M. Biffen-Commercial methods of analysis-D.B. Taraporavala & sons,
5. J.J. Elving and I.M. Kolthoff- Chemical analysis - A series of monographs on analytical chemistry and its applications -- Inter Science- Vol I to VII.,
6. G.Z. Weig - Analytical methods for pesticides, plant growth regulators and food additives - Vols I to VII,
7. Aanalytical Agricultural Chemistry by S.L. Chopra & J.S. Kanwar -- Kalyani Publishers
8. Mannual of soil, plant, water, and fertilizer analysis, R.M. Upadhyay and N.L Sharma, Kalyani Publishers

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