MAJOR COURSES

SEMESTER-I

MAJOR COURSE

MAJOR COURSE –MJ 1: ATOMIC STRUCTURE, CHEMICAL BONDING & REDOX REACTIONS

Credit: Theory-04, Full Marks=100, Pass Marks= 40, Lectures:60

Marks: 25 (5 Attendance+ 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100 Pass Marks: Th (SIE + ESE) = 40

Instruction to Question Setter for
Semester Internal Examination (SIE 20+5=25 marks):
The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.
End Semester Examination (ESE 75 marks):
There will be two group of questions A and B. Group A is compulsory which will contain three questions. Question No.1 will be very short answer type consisting of five questions of 1 mark each. Question No. 2 & 3 will be short answer type of 5 marks. Group B will contain descriptive type seven questions of fifteen marks each, out of which any four are to be answered.
Note: There may be subdivisions in the questions of group B.
Course Objectives:
On completion of this course, the students will be able to understand:
Learning objective:

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table; physical and chemical characteristics, periodicity.
4. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
5. To understand atomic theory of matter, composition of atom.
6. Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form different atoms.
7. Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
8. Characterize bonding between atoms, molecules, interaction and energetics (ii) hybridization and shapes of atomic, molecular orbitals, bond parameters, bond-distances and energies.
9. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
10. Importance of hydrogen bonding, metallic bonding.
11. Principles of Volumetric Analysis.

Course Learning Outcomes:
On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules
3. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication

Unit-1 Atomic Structure: (12 Lectures)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $\psi 2$. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and

04.4.24

probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit-2 Periodicity of Elements: (12 Lectures)

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. , Atomic radii (Vander Waals) ,Ionic and crystal radii, Covalent radii (octahedral and tetrahedral) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy, Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity, Sanderson electron density ratio.

Unit-3 Chemical Bonding: (30 Lectures)

a) **Ionic bond:** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation, Madelung constant, expression for lattice energy, Kapustinskii equation. Born-Haber cycle and its application, Solvation energy.
b) **Covalent bond:** Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone and bond pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory, Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules: N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions. Covalent character in ionic compounds; polarization, polarizing power and polarizability. Fajan rules. Ionic character in covalent compounds: Bond moment and dipole moment, ionic character from dipole moment and electronegativities.
c) **Metallic Bond:** Qualitative idea of free electron model, Semiconductors, Insulators.
d) **Weak Chemical Forces:** Vander Waals, ion-dipole, dipole-dipole, induced dipole dipole-induced dipole interactions, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution

Unit-4: Oxidation-Reduction and Volumetric Analysis: (6 Lectures)

Redox equations, Balancing by Ion electron method & Oxidation number method. Disproportionation Reaction. Principles involved in volumetric analysis.

References:

1. Lee, J.D. (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
5. Pfennig, B. W. (2015), Principles of Inorganic Chemistry. John Wiley & Sons.
6. Housecraft, C. E.; Sharpe, A. G., (2018), Inorganic Chemistry, 5th Edition, Pearson.
7. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
8. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition,Pearson.
9. Shiver, D.; Weller, M.; Overton, T.; Rourke, J.; Armstrong, F. (2014), Inorganic Chemistry, 6th Edition, Freeman & Company
10. Das, A. K.; Das, M. (2014), Fundamental Concepts of Inorganic Chemistry, 1st Edition, Volume CBS Publishers & Distributors Pvt. Ltd.

04.4.24