Course Code	Course Title	L	P	U
CHE111T	**Inorganic Chemistry I**	**4**	**0**	**4**

Scope & objective of the course:

This course is offered in the first semester for the BSc in Chemistry students. The prime purpose of this course is to understand the structure of the atom and how their properties (physical as well as chemical) changes from periodic table of the elements. In order to this formation of chemical bond and different aspects of the chemical phenomena discussed in this course.

Learning outcomes:

After completion of this course, students can build their theoretical knowledge of the basics of inorganic chemistry. Students can impart essential theoretical knowledge on atomic structure, periodic properties, chemical bonding, and oxidation–reduction reaction process. Students can build their problem solving skill of various topics of inorganic chemistry especially the topic on atomic structure, periodic properties, chemical bonding, and oxidation–reduction. In the course curriculum through their board presentation they can develop their presentation skill as well. Apart from that students also can—

- Able to write electronic configuration of given atomic number and name of orbitals by recognizing shapes of orbitals.
- Able to draw MO diagrams of different molecules and to calculate bond order of different molecules.
- Able to calculate effective nuclear charge using Slater's Rule.
- Able to draw structures of different ionic solids.

Module 1: Atomic Structure:

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 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.

Module 2: Periodicity of Elements:

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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 & p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy; trends of electron gain enthalpy. (g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

Module 3: Chemical Bonding:

(i) lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, CO, NO, and their ions; HCl, BeF2, CO2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. (iii) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Module 4: Oxidation-Reduction:

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

Text book (s):

T1: Inorganic Chemistry: James E. House. Academic Press.

T2: Concise Inorganic Chemistry: J.D.Lee: Black Well Science, OUP, 5th Edition, 1996.

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T3: Inorganic Chemistry: Huheey, Keiter & Keiter: Pearson Education, 2003.

T4: General and Inorganic Chemistry [Part I]: R.P. Sarkar: New Central Book Agency (P) Ltd., 2007.

Reference book (s):

R1: D. F. Shriver, P.W. Atkins and C.H. Landgord, Inorganic Chemistry, 3rd Edn., Oxford University Press, 1998.

R2: N. N. Greenwood and A. Earnshaw, Chemistry of the elements, Pergamon, Oxford, 1984.

Lecture-wise Plan:

Lecture Nos.	Learning Objective	Topics to be covered	Reference (Ch./Sec./ Page Nos.of Text Book)
1-4	Bohr's theory, De Broglie equation, Heisenberg's Uncertainty principle	**Atomic Structure:** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance.	T1/1/1.1–1.5/3–21
5 – 9	(i) Schrödinger's wave equation (ii) Quantum numbers (iii) Radial and angular wave functions for hydrogen atom (iv) Radial and angular	Schrödinger's wave equation, significance of ψ and ψ^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.	T2/1/1.6–1.7/12–15 T4/3/3.3.1–3.3.4/51–70

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10– 12	(i) Shapes of *s*, *p*, *d*and *f* orbitals. (ii) Pauli'sExclusion Principle (iii) Hund's rule (iv) Aufbau's principle	Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and 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.	T2/1/1.8–1.11/16–25 T4/3/3.4–3.6/76–89
13 – 15	(i) Modern periodic table, *s*, *p*, *d*, *f* block elements	*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*	T4/4/4.1–4.2/93–98
16 – 20.	(i) Effective nuclear charge (ii) Van der Waals radii (iii) Covalent radii (iv) Ionic radii	(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (Van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral)	T4/4/4.3/99–106
21– 26	Ionization energy, Electron affinity, Electronegativity	(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electron affinity (h) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity	T4/4/4.3/106–113

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27 –29	(i) Variation of electronegativity with bond order (ii) Hybridization and group electronegativity.	Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.	T4/4/4.3/113–116
30–34	(i) Lattice energy and solvation energy (ii) Radius ratiorule (iii) Packing of ionsin crystals (iv) Born Landé equation (v) Born-Habercycle	(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, solvation energy.	T4/6/6.1–6.8/133–156
35– 39	(i) Covalent bond: Lewis structure (ii) Valence Bond theory (iii) Bent'srule (iv) Resonance and resonance energy	(ii) *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy.	T4/7/7.1/161–184
40– 44	(i) Valence shell electron pair repulsion theory (VSEPR) (ii) Molecular orbital theory (iii) Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO	Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.	T4/7/7.2–7.5/184–207

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45– 50.	(i) Valence shell electron pair repulsion theory (VSEPR) (ii) Molecular orbital theory (iii) Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO	Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. (iii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.	T4/6/6.4/136–140 T4/7/7.2–7.5/208–210 T2/5/5.3/131–144
51– 56	(i) Van der Waals forces (ii) Dipole-dipole interactions (iii) Hydrogen bonding interactions	(iv) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.	T4/7/7.2–7.5/202–207
57– 60	(i) Redox equations (ii) Standard Electrode Potential (iii) Principles of volumetric analysis	**Oxidation-Reduction** : Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.	T4/8/8.1–7.5/227–241

Evaluation Scheme:

Component	Duration	Weightage (%)	Remarks
Internal I		25	Assignments/Viva/ Presentation

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Mid Term	2 hrs.	20	Closed Book
Internal II		25	Assignments/Viva/ Presentation
Comprehensive	3 hrs.	30	Closed Book

1. **Attendance Policy:** A Student must normally maintain a minimum of **75% attendance** in the course without which he/she shall be disqualified from appearing in the respective examination.

2. **Make-up Policy:** A student, who misses any component of evaluation for genuine reasons, must immediately approach the instructor with a request for make-up examination stating reasons. **The decision of the instructor in all matters of make-up shall be final**.

3. **Chamber Consultation Hours:** During the Chamber Consultation Hours, the students can consult the respective faculty in his/her chamber without prior appointment.

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