Lahore University of Management Sciences

CHEM 101 – Principles of Chemistry

Fall 2023-24

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TA Office Hours	Details shared separately on LMS
Course URL (if any)	

Course Teaching Methodology (Please mention the following details in plain text)

- Teaching Methodology: In person.
- Lecture Details: Two lectures per week aided by tutorial sessions and office hours.

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2 (TuTh, 4:30 pm – 5:45 PM)	Duration	75 min
Recitation/Lab (per week)	Nbr of Lec(s) Per Week		Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week	TBA	Duration	TBA

Course Distribution	
Core	Core Course for SBASSE undergraduate programs
Elective	
Open for Student Category	BS Students
Close for Student Category	

COURSE DESCRIPTION

Innovations in Chemistry and Chemical Engineering provide products and processes that improve and sustain our lives by contributing to advancements in health, energy, environment, transportation, electronics, communication, and all other technological sectors. Designing new medicines and therapeutic procedures, understanding how the molecular machinery of cells – and life for that matter - functions, developing efficient, reliable and sensitive diagnostic platforms, increasing the efficiency of solar cells and making solar energy economical, making batteries charge faster and last longer, making fuel cells running on hydrogen a viable green energy generation technology, increasing the speed at which electronic and communication devices operate and enhancing their data storage capacity while reducing their size, increasing security of the ever-expanding cloud storage platforms, developing innovative display and lighting technologies, creating next-generation semiconductors, are just glimpses of the areas where the disciplines of Chemistry and Chemical Engineering are making immense contributions.

This course will introduce and discuss the following tops.

Atomic Structure: General information about the atom and how the theory of the atomic structure evolved. Discovery of the electron, the Plum pudding model of atom, Rutherford's model of the atom, Max Planck's relationship, emission spectra of atoms and Bohr's theory. Wave-particle duality and De Broglie waves.

Introduction to Quantum Mechanics: Failure of classical mechanics. The concept of the wavefunction, orbitals and the radial distribution function, Hydrogen atomic orbitals, quantum numbers, orbitals and energies, Hydrogen-like ions, Multi-electron atoms, concepts of shielding, penetration and effective nuclear charge, orbital energies of excited states and of empty orbitals and ionization energies,.

Electrons in Molecules: Molecular orbitals (MO), a linear combination of atomic orbitals, molecular orbital diagrams homonuclear diatomics Lewis dot structures, of the second period, hybrid atomic orbitals, sp3 hybrids, sp2 hybrids and sp hybrids, photoelectron spectra.

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Trends in Bonding: Electronic configuration and the periodic table, orbital energies and effective nuclear charges, the second-period anomaly, electronegativity and orbital energies, atomic sizes across the periodic table, ionization energies and electron affinities, bonding in the non-metals and metals, the transition from metals to non-metals, ionic solids, Metallic bonding

Electronic materials: properties of metals and insulators, band theory of solids (Drude; Bloch; Heitler and London), band gaps in metals, semiconductors, and insulators, thermal excitation, photoexcitation, the Maxwell-Boltzmann distribution, intrinsic and extrinsic semiconductors, doped materials, compound semiconductors, p-n junction and their applications; LED, solar cells, OLED.

Magnetic materials: Introduction to the solid state: crystals and lattices, properties of cubic crystals; introduction to x-rays, generation of x-rays; characterization of atomic structure, Moseley's law, diffusion law, Fick's laws;

Acid-Base Equilibria: Classification of acids and bases, acidity and basicity in terms pKa, competition between two acids, leveling effect of solvent, the pH of solutions of weak acids, and buffer solutions.

Introduction to organic chemistry and spectroscopy.

COURSE PREREQUISITE(S)	
•	None

COURSE OBJECTIVES	
1)	Introduce atomic theories to solve problems related to the energy of electrons in atoms and molecules.
2)	Introduce theories to determine the shape, bonding characteristics, and band diagrams of different molecules.
3)	Introduce fundamentals of thermodynamics, acid-base equilibria, organic and polymer chemistry, and spectroscopy.

Course Learning Outcomes	
	The students should be able to:
1)	Understand and apply concepts of different atomic theories to solve problems related to the energy of electrons in atoms and molecules.
2)	Apply different bonding theories to determine the shapes of different molecules, their bonding characteristics, and band diagrams.
3)	Understand the fundamentals of thermodynamics, acid-base equilibria, organic chemistry and spectroscopy.

Relation to Program Outcomes

CHEM101 CLOs	Related PLOs	Levels of Learning	Teaching Methods	CLO Attainment checked in
CLO1	PLO1, PLO2	Cog-3	Instruction, Tutorial, Assignments	Midterm, Final
CLO2	PLO1, PLO2	Cog-3	Instruction, Tutorial, Assignments	Midterm, Final
CLO3	PLO1, PLO2	Cog-3	Instruction, Tutorial, Assignments	Midterm, Final

Grading break up: Component Details and weightages

1. **Quizzes: 25%**, In total, there will be 6 announced quizzes, and all these quizzes will count towards the final grade. These quizzes will be taken at any time during the class lectures.
2. **Surprise quizzes:** There will be 4- 8 surprise quizzes. These quizzes can be taken at any time during the class! These quizzes will have the following weightages:
   (a). Replacement Policy: *Anyone who misses just a single surprise quiz, out of all surprise quizzes taken, will have his/her* ***one worst announced quiz*** *replaced by the* ***best surprise quiz****. If someone* ***misses 2 or more surprise quizzes****, he or she* ***will not be eligible*** *for this quiz* ***replacement policy****.*
   (b). Bonus Marks: *If anyone takes* ***all the announced and all surprise quizzes****, he or she will be given* ***10 bonus marks****.*
3. **Midterm Examination: 35%**
4. **Final Examination: 40%**

Assignment(s): There will be 4-6 assignments during this course. These assignments will not be graded; however, up to 20 % of quizzes, midterm, and final exams will include questions from these assignments.

These details might change and will be communicated to the students. The instructor can change the grading policy up to 5% at any time during the semester.

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Examination Detail	
Midterm Exam	**Yes/No:** Yes **Combine Separate:** One/two midterm Exam/s **Duration:** 90-120 minutes **Dates:** Midterm Exam (communicated later) **Exam Specifications:** Can contain MCQs, True/False or fill in the blanks as well as short descriptive questions including numerical. These details might change and will be communicated to the students well in time.
Final Exam	Yes/No: Yes Combine Separate: One final Exam Duration: 120-180 minutes Exam Specifications: Can contain MCQs, True/False or fill in the blanks as well as short descriptive questions including numerical.

	COURSE OVERVIEW				
Module	**Lectures**	**Topics**	**Recommended Readings**	**Objectives/ Application**	**Related CLOs**
Atom	**1**	Introduction to the course	(KW) (SZ)	Introduce course content. Trigger the discussion about the nature of matter.	CLO1
	2-5	Discussion on Rutherford and Bohr's models; Photoelectric effect and De Broglie's hypothesis	Chapter 2 (KW) Chapter 7 (SZ)	Describe the arrangement of electrons and the nature of orbitals	CLO1
	6-9	Elections in an atom, Wavefunction, orbitals, quantum numbers. Orbital shapes and energies of the H atom. Electron spin and Pauli Principle	Chapter 2 (KW) Chapter 7 (SZ)	Describe the shape and energy of the orbitals in one electron system.	CLO1
	10-12	Polyelectronic atoms, Energies of orbitals and Z effective, Periodic Trends	Chapter 2, 8 (KW) Chapter 7 (SZ)	Describe the shape and energy of the orbitals in systems containing more than one electron.	CLO1
Bonding Theories	**13-16**	Types of Chemical Bonds, Localized electron bond model, Lewis dot structure, VSEPR Theory, Molecular Orbital Theory	Chapter 4, 5 (KW) Chapter 8, 9 (SZ)	To understand how the combinations of atomic orbitals result in molecular orbitals and bonding in simple molecules.	CLO1 & CLO2
Bonding in Solids- applications	**17-20**	Bonding in solids, Types of solids, packing in solids, Introduction to bands, Bands in one dimension, Conduction of electricity, Bands from molecular orbitals, Band gaps and semiconductors, and Band gaps in graphite. Applications to Solar cells and LEDs.	Chapter 6 (KW) Chapter 10 (SZ)	To understand and apply how the combinations of atomic orbitals result in crystal orbitals or delocalized molecular orbitals extending throughout the material. To understand the electrical conductivity and bandgap	CLO2
Intro to Thermodynamics	**21-23**	Laws of thermodynamics, heat, work, energy, enthalpy, entropy, Gibbs free energy, spontaneity; strong and weak acids and bases, pH calculations of strong and weak acids and based and buffer solutions	Chapters 10 (SZ)	To understand and apply concepts of thermodynamics to solve problems related to enthalpy. Entropy and spontaneity. To be able to calculate pH of weak and strong acids and bases and different buffer solutions.	CLO2 &CLO3
Chemical Equilibria- Acids & Bases	**24-28**	Theories concerning acids and bases; application of these concepts to understand and explain various chemical	Chapters 6 & 7 (SZ)	Understand and calculate the pH of strong and weak acids & bases, Buffers, and their applications	

		reactions; principles and role of buffers, in particular to life sciences and understanding and application of weak/strong acid-base concepts to explain different titration curves			CLO2 &CLO3
Intro to Organic Chemistry	**29-30**	Organic chemistry – Functional groups and their transformations. Introduction to IR spectroscopy.	Chapter 2 (SFS), Chapter 22 (SZ), and Chapter 27: Organic Chemistry by Paula Yurkanis Bruice 7th Edition	Rationalizing the functional group transformation in organic reactions. Describe the types of polymers, their synthesis, and applications. To understand how to reveal the chemical structure of a substance.	CLO2

Textbook(s)/Supplementary Readings

1) Chemical Structure and Reactivity – James Keeler and Peter Wothers (KW) 2nd Edition
2) Chemical Principles – Steven Zumdahl (SZ) 5th Edition
3) Organic Chemistry – Solomons, Fryhle, Snyder (SFS) 12th Edition
4) Organic Chemistry by Paula Yurkanis Bruice 7th Edition

Harassment Policy

SSE, LUMS and particularly this class, is a harassment free zone. There is absolutely zero tolerance for any behavior that is intended or has the expected result of making anyone uncomfortable and negatively impacts the class environment, or any individual's ability to work to the best of their potential.

If you think that you may be a victim of harassment (any form, through any means), or if you have observed any harassment occurring in the purview of this class, please reach out and speak to me. If you are a victim, I strongly encourage you to reach out to the Office of Accessibility and Inclusion at oai@lums.edu.pk or the harassment inquiry committee at harassment@lums.edu.pk for any queries, clarifications, or advice. You may choose to file an informal or a formal complaint to put an end to the offending behavior.