



Course Outline

Programme	BS Science Education	Course Code	SE-303+SE-303L	Credit Hours	3
Course Title	CHEMISTRY-II (INORGANIC CHEMISTRY)				
Course Introduction					
<p style="text-align: center;">This course provides students with a comprehensive understanding of the fundamental principles and applications of Inorganic Chemistry. It aims to develop their analytical and problem-solving skills by exploring topics such as Periodic table, Chemical bonding, d-block, acid and bases, chemical industry enabling them to apply these concepts to real-world chemical systems and processes.</p>					
Learning Outcomes					
<p>On the completion of the course, the students will:</p> <ol style="list-style-type: none"> 1. Understand the development of periodic law and properties of elements in a systematic way. 2. Understand and apply the principal of chemical bonding 3. Understand the role of the chemistry of acid and bases 4. Development concepts of Chemistry of p-block Elements 5. Appreciate the role Chemistry of d- block Elements 5. Understand fundamental principles of industrial process 					
Course Content				Assignments/Readings	
Week 1	Unit-I 1. The Structure of the Atom 1.1 Inner picture of an atom: Subatomic particles, discovery of subatomic Particles models of the atom described by Rutherford and Bohr,.			Reading: Cotton, F, Albert, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3 rd Edition (1995).	

	1.2. Energy of an electron, Radius of an orbit, Origin of spectral lines in different Elements.	Reading: Cotton, F, Albert, Geoffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Inc, 3 rd Edition (1995).
Week 2	1.3. Summerfield's modification, Non quantum to Quantum transition of history of Atomic Structure.	Assignment: Write a short explanation of the transition of atom over the history.
	Unit-II Periodicity 2.1 Modern periodic table, Similarities and differences in first row elements, their diagonal and vertical relationship with other elements;.	Reading: Lee, J.D., "Modern Inorganic Chemistry", Chapman & Hall, 5 th Edition (1996).
Week 3	2.2 Electro negativity of elements (Pauling and Mullikan scales).	Reading: Lee, J.D., "Modern Inorganic Chemistry", Chapman & Hall, 5 th Edition (1996).
	2.3 Polarizability and polarizing power of ions; Periodicity in the properties of transition and inner transition elements	Assignment: Write a report on the trend of electronegativity across the periodic table.
Week 4	Unit-III Theories of Chemical Bonding 3.1 Nature and types of chemical bonding; explaining the conventional and modified MO diagrams;	Reading: Jolly, William, L., "Modern Inorganic Chemistry", McGraw Hill, 2 nd Edition (1991).
	3.2 Modern concept of valence bond theory (VBT), molecular orbital theory (MOT) and their applications to homo and hetero di- and polyatomic inorganic molecules,	Reading: Jolly, William, L., "Modern Inorganic Chemistry", McGraw Hill, 2 nd Edition (1991).
Week 5	3.3. Valence shell electron pair repulsion theory (VSEPR).	Reading: Jolly, William, L., "Modern Inorganic Chemistry", McGraw Hill, 2 nd Edition (1991).

	3.4. explaining the shapes of inorganic molecules (i.e. AB ₂ , AB ₃ , AB ₂ E, AB ₄ , AB ₃ E, AB ₂ E ₂ , AB ₅ , AB ₄ E, AB ₃ E ₂ , AB ₂ E ₃ , AB ₆ , AB ₅ E, AB ₄ E ₂) and directed valence theory (Hybridization), Metallic bonds (detailed concept).	Assignment: Draw structures of 7-8 molecules based on types of hybridization.
Week 6	4. Acid-Base Concept 4.1. General concept of acids and bases.	Reading: Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2 nd Edition (1996).
	4.2. Detail of Lewis concept of acids and bases; Soft and hard acid-base (SHAB) concept and its applications.	Reading: Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2 nd Edition (1996).
Week 7	4.3 Relative strength of acids and bases based on Pk values. Reactions of acids and bases.	Reading: Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2 nd Edition (1996).
	4.4. Relationship between redox reactions and acid base reactions. Indicators and theory of indicators.	Assignment: Visit any grocery store and make a checklist of the ingredients of any products considering them on the acid or base.
Week 8	Unit 5 Chemistry of d-Block Elements 5.1 Electronic configuration and oxidation states of transition elements	Reading: Sharp, A.G. "Inorganic Chemistry", Longman, 3 rd Edition (1992).
	5.2. Metallurgy of chromium, nickel and copper.	Reading: Sharp, A.G. "Inorganic Chemistry", Longman, 3 rd Edition (1992).
Week 9	5.3. Theories of coordination compounds, valence bond theory (VBT), molecular orbital theory (MOT) and crystal field theory (CFT) for tetrahedral and octahedral complexes.	Reading: Sharp, A.G. "Inorganic Chemistry", Longman, 3 rd Edition (1992).

	5.4. Nomenclature and Isomerism in coordination compounds.	Reading: Sharp, A.G. "Inorganic Chemistry", Longman, 3 rd Edition (1992).
Week 10	5.5. What are Chelates, nomenclature and functioning.	Reading: Sharp, A.G. "Inorganic Chemistry", Longman, 3 rd Edition (1992).
	5.6. Application of coordination compounds.	Assignment: Write a review on Atomic theories.
Week 11	Unit 6 Nuclear Chemistry 6.1. Phenomena of radioactivity; Natural radioactivity measurement of nuclear radiation, Nuclear reactions (fission and fusion),	Reading: Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
	6.2. Radioactive disintegration series,	Reading: Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
Week 12	6.3. , Rate of disintegration and half life period, Mass defect and binding energy, nuclear stability;	Reading: Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
	6.4 Wilson cloud chamber and Geiger-Muller counter, Carbon dating;	Reading: Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
Week 13	6.5. Artificial radioactivity and nuclear transformations,	Reading: Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
	6.6. Uses of radioactive isotopes; Biological effect of nuclear radiation.	Assignment: Note on How can we avoid nuclear pollution, suggestion.
Week 14	Unit 7 Chemical Industries 7.1. Chemical Industries: Introduction to Glass Industry,	Reading Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, "Vogel's text book of Quantitative Chemical analysis", 5 th

		Education, Benjamin Cummings, (1989).
	7.2. Chemical composition of different glass types, applications, hazardous.	Reading Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, “Vogel’s text book of Quantitative Chemical analysis”, 5 th
Week 15	7.3. Chemical Industries: Introduction to Soda ash Industry, chemical composition of different different types,	Reading Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, “Vogel’s text book of Quantitative Chemical analysis”, 5 th
	7.4. Applications, hazardous of Soda Ash industry.	Reading Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, “Vogel’s text book of Quantitative Chemical analysis”, 5 th
Week 16	7.5. Chemical Industries: Introduction to Soap Industry, chemical composition and different types.	Reading Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, “Vogel’s text book of Quantitative Chemical analysis”, 5 th
	7.6. Applications and hazardous of Soap Industry.	Assignment: Visit any of the industry and write the detail. (field visit).
Textbooks and Reading Material		
Textbooks.		
Books Recommended:		
1. Cotton, F, Albert, Geoffrey Wilkinson and Paul L. Gaus, “Basic Inorganic Chemistry”, John, Wiley & Sons Inc, 3 rd Edition (1995).		
2. Lee, J.D., “Modern Inorganic Chemistry”, Chapman & Hall, 5 th Edition (1996).		
3. Jolly, William, L., “Modern Inorganic Chemistry”, McGraw Hill, 2 nd Edition (1991).		
4. Shriver, D.F., P.W. Atkins and C.H. Langford, “Inorganic Chemistry”, Oxford, 2 nd Edition (1996).		
5. Sharp, A.G. “Inorganic Chemistry”, Longman, 3 rd Edition (1992).		
6. Rayner Canham, Geiof., “Descriptive Inorganic Chemistry” & Co. (1995).		
7. Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, “Vogel’s text book of Quantitative Chemical analysis”, 5 th Education, Benjamin Cummings, (1989).		
7.1. Journal Articles/ Reports		

Note:

8. It is preferable to use latest available editions of books. Mention the publisher & year of publication.
9. The References/ bibliography may be in accordance with the typing manual of the concerned faculty/subject. Preferably follow APA 7th Edition publication manual.

Teaching Learning Strategies

1. Lectures with Visual Aids
2. Problem-Solving Sessions
3. Group Discussions and Peer Learning
4. Hands-On Computational Exercises
5. Case Studies and Real-World Applications

Assignments: Types and Number with Calendar**1. Types of Assignments:**

1.1. **Numerical Problem-Solving:** Application-based problems.

1.2. **Short Reports:** Writing brief explanations or summaries.

1.3. **Derivations and Mathematical Proofs:** Step-by-step understanding of the concepts with models.

1.4. **Real-World Applications:** Researching and reporting on practical uses of chemistry principles

1.5. **Comparative Analysis:** Comparing theoretical and experimental results,

2. Number of Assignments:

2.1. **Before Midterm:** 2 Major assignments.

2.2. **After Midterm:** 2 Major assignments.

This approach ensures a balance of theoretical understanding and applied learning throughout the course.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.



Course Outline

Programme	BS Science Education	Course Code	SE-303L	Credit Hours	1
Course Title	CHEMISTRY LAB-II (INORGANIC CHEMISTRY LAB)				
Course Introduction					
<p>This course provides students with a comprehensive understanding of the fundamental principles and applications of Inorganic Chemistry. It aims to develop their analytical and problem-solving skills by exploring topics such as Periodic table, Chemical bonding, d-block, acid and bases, chemical industry enabling them to apply these concepts to real-world chemical systems and processes.</p>					
Learning Outcomes					
<p>On the completion of the course, the students will:</p> <ol style="list-style-type: none"> 1. Prepare and standardize solutions for laboratory experiments. 2. Investigate reaction kinetics and interpret experimental data. 3. Apply principles to measure conductance and solubility. 4. Determine physical properties like molecular weight, partition coefficients, and phase diagrams. 5. Use analytical instruments to measure optical properties and concentrations of compounds. 					
Course Content				Assignments/Readings	
Week 1	Orientation			Reading: Basics of solution preparation by Atkins, Chapter 1.	
	Laboratory safety protocols, chemical handling, Experimentation protocols				
Week 2	Solution preparation			Reading: Basics of solution preparation by Atkins, Chapter 1.	
Solution preparation, percentage solution, Normal solutions, Molar and Molal solutions, different concentration solutions. \					

Week 3	<p>UNIT 1 PAPER CHROMATOGRAPHY</p> <p>1.1. Preparation of standard molar and normal solutions; percentage compositions of different compounds.</p>	<p>Reading: Javed Iqbal, Amin, "Theory and Practice of chromatography", Higher Education Commission, Islamabad, (2002).</p>
Week 4	<p>1.2. Separation & identification of cations/basic radicals of group I, II.A, II.B & III. Also calculate their R_f values.</p>	<p>Javed Iqbal, Amin, "Theory and Practice of chromatography", Higher Education Commission, Islamabad, (2002).</p>
Week 5	<p>Unit-II ARGENTOMETRY</p> <p>2.1 MOHR'S METHOD</p> <p>2.1. Determine the %age purity of NaCl (rock salt)</p>	<p>Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994).</p>
Week 6	<p>2.2. Determine the amount of NaCl in the commercial sample of soda ash.</p>	<p>Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994).</p>
Week 7	<p>Unit-III VOLHARD'S METHOD</p> <p>3.1. Determination of %age purity of HCl.</p>	<p>Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994).</p>
Week 8	<p>3.2. Determination of silver in the given sample, using KSCN or NH₄SCN</p>	<p>Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994).</p>
Week 9	<p>Unit-IV REDOX TITRATIONS (By using both internal and external indicators)</p> <p>4.1. Determination of amount/dm³ of FeSO₄.7H₂O with K₂Cr₂O₇.</p>	<p>Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994).</p>

Week 10	Unit-IV REDOX TITRATIONS (By using both internal and external indicators) 4.2. Determination of %age purity of $K_2Cr_2O_7$ by using standard solution of Mohr's salt.	Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6 th Edition, Saunders College Publications, (1994).
Week 11	Unit-IV REDOX TITRATIONS (By using both internal and external indicators) 4.3. Determination of number of water molecules (x) in $FeSO_4 \cdot xH_2O$ using $K_2Cr_2O_7$.	Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6 th Edition, Saunders College Publications, (1994).
Week 12	Unit-IV REDOX TITRATIONS (By using both internal and external indicators) 4.4. Determination of Ca^{2+} by $KMnO_4$.	Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6 th Edition, Saunders College Publications, (1994).
Week 13	Unit-IV REDOX TITRATIONS (By using both internal and external indicators) 4.5. Determination of %age of iron in ferric alum $(NH_4)_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$ using $K_2Cr_2O_7$.	Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6 th Edition, Saunders College Publications, (1994).
Week 14	Unit-V COMPLEXOMETRY 5.1. Standardization of EDTA solution by magnesium/zinc sulfate solution.	Reading Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6 th Edition, Saunders College Publications, (1994).
Week 15	Unit-V COMPLEXOMETRY 5.2. Find out the amount of Ca^{2+} in the given sample of marble (lime stone).	Reading: Applications of phase diagrams from <i>Physical Chemistry</i> by Atkins
Week 16	Unit-V COMPLEXOMETRY 5.3. Determination of Ca^{2+} and Mg^{2+} in the sample by using EDTA.	Reading: Optical activity and polarimetry from <i>Physical Chemistry</i> by Engel and Reid
Textbooks and Reading Material		
Textbooks.		
1.1. Advanced Experimental Chemistry		

- 1.2.Vogel, “A.I.A. Text Book of Macro and Semi micro-qualitative Inorganic Analysis”, Longamn Green & Co., (1995).
- 1.3.Skoog, D.A., D.M. West and F.J. Holler, “Analytical Chemistry”, 6th Edition, Saunders College Publications, (1994).
- 1.4.Javed Iqbal, Amin, “Theory and Practice of chromatography”, Higher Education Commission, Islamabad, (2002).

2. Suggested Readings (Students can explore by themselves)

2.1.Books

2.2.Journal Articles/ Reports

Note:

3. It is preferable to use latest available editions of books. Mention the publisher & year of publication.
4. The References/ bibliography may be in accordance with the typing manual of the concerned faculty/subject. Preferably follow APA 7th Edition publication manual.

Teaching Learning Strategies

1. Hands-On Laboratory Experiments
2. Demonstration-Based Learning
3. Problem-Solving Sessions
4. Collaborative Group Work

Assignments: Types and Number with Calendar

1. **Prepare Solutions:**
Make a saltwater solution (e.g., 0.1 M NaCl) and a sugar solution (5%) using household tools.

Note:

Two assignments taking before mid-term and remaining two will be the part of final term.

Assessment

Sr. No.	Elements	Weightage	Details
2.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

3.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
4.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.



Course Outline

Programme	BS Science Education	Course Code	SE-303A	Credit Hours	04
Course Title	Mathematics B-I [Vectors & Mechanics (I)]				
Course Introduction					
<p>This Vectors & Mechanics (I), course provides foundational understanding of vectors and their application in mechanics, focusing on both theoretical concepts and practical problem-solving skills. Students will explore the nature of vectors, including their representation, addition, and applications in describing physical phenomena. An exciting course that will unlock the laws of motion and the power of vectors, fundamental concepts that are essential to understanding the physical world around us.</p>					
Learning Outcomes					
<p>On the completion of the course, the students will:</p> <ol style="list-style-type: none"> 1. Understand the fundamental concepts related to vectors and their application in mechanics. 2. To develop skills in vector representation, operations, and their geometric interpretations. 3. Acquire the knowledge about mechanics related to forces, friction and virtual work. 4. Mastery to solve a problem about mechanics and vector in daily life. 					
Course Content					
Week 1	Unit -1: Vector Algebra				
	1.1	Introduction to vector algebra			
Week 2	1.2	Scalar and vector product			
	1.3	Scalar triple product and vector triple product			
Week 3	1.4	Applications to geometry			
	Unit-2: Vector Calculus				
Week 3	2.1	Limit, continuity and differentiability of vector point functions			
	2.2	Partial derivatives of vector point functions			

Week 4	2.3	Scalar and vector fields
	2.4	The gradient, divergence and curl
Week 5	2.5	Expansion formulas.
		Unit-3: Forces
Week 6	3.1	Fundamental concepts and principles
	3.2	Inertial-non-inertial frames, Newton's laws
Week 7	3.3	Resultant of several concurrent forces
	3.4	The parallelogram law of forces
Week 8	3.5	Resolution of a forces, triangle of forces
	3.6	Lamy's theorem, polygon of forces
Week 9	3.7	Conditions of equilibrium for a particle
	MID- TERM EXAM	
Week 10	PRESENTATIONS	
	QUIZZES	
Week 11	3.8	External and internal forces, principle of transmissibility
	3.9	Resultant of like and unlike parallel forces
Week 12	3.10	Moment of forces about a point, Varignon's theorem
	3.11	Moment of a couple, equivalent couples, composition of couples
Week 13	3.12	Reduction of coplanar forces to a force or a couple
		Unit-4: Friction
Week 14	4.1	Dry friction and fluid friction
	4.2	Laws of dry friction, coefficients of friction, angle of friction
Week 15	4.3	Equilibrium of a particle on a rough inclined plane
	4.4	Particle on a rough inclined plane acted on by an external force
Week 16	4.5	Conditions for sliding or titling
		Unit-5: Virtual Work
Week 16	5.1	Principle of virtual work
	5.2	Problems involving tensions and thrust
Textbooks and Reading Material		
1. Thomas, <i>Calculus</i> , 11 th Edition. Addison Wesley publishing company, 2005		
2. Jafferson, B. Beadsdworth, T. <i>Further Mechanics</i> , Oxford University Press, 2001		

3. Joseph F, Shelley. *Vector Mechanics*, Mc-Graw Hill Company, 1990
4. Murray R. Spiegel, *Theoretical Mechanics*, Schaum's Outline Series, Mc Graw Hill Book Company
5. Hwei P. HSU, *Applied Vector Analysis*, San Diego, New York, 1984.
6. Murray R. Spiegel, *Vector Analysis*, Schaum's Outline Series, McGraw Hill Book Company, 1959

Teaching Learning Strategies

- Lecture Method
- Collaborative Method
- Problem-Solving Approaches
- Demonstration Method
- Project Method
- Connecting mathematics to real world context
- Discussion

Assignments: Types and Number with Calendar

- Class presentation, Quizzes.
- 1st assignment before mid-term exam.
- 2nd assignment after mid-term exam

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester. It will be a written test.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.

3.	Final Assessment	40%	Written Examination at the end of the semester. It will be a written test.
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