**University of the Punjab, Lahore**

# Course Outline

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| **Programme** | BS Science Education | **Course Code** | **SE-303+SE-303L** | **Credit Hours** | 3 |
| **Course Title** | **CHEMISTRY-II (INORGANIC CHEMISTRY)** | | | | |

## Course Introduction

**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.**

## Learning Outcomes

On the completion of the course, the students will:

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**<br>1.1 Inner picture of an atom: Subatomic particles, discovery of subatomic Particlesmodels 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, 3rd Edition (1995). |

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| | 1.2. Energy of an electron, Radius of an orbit, Origin of spectral lines in different Elements. | **Reading:** Cotton, F, Albert, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3rd Edition (1995). |
| **Week 2** | 1.3.Summerfield's modification, Non quantum to Quantum transition of history of Atomic Struction. | **Assignment:** Write a short explanation of the transition of atom over the history. |
| | **Unit-II Periodicity**<br>2.1 Modern periodic table, Similarities and differences in first row elements, their diagonal and vertical relationship with other elements;. | **Reading:** Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th Edition (1996). |
| **Week 3** | 2.2 Electro negativity of elements (Pauling and Mullikan scales). | **Reading:** Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th 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 cross the periodic table. |
| **Week 4** | **Unit-III Theories of Chemical Bonding**<br>3.1 Nature and types of chemical bonding; explaining the conventional and modified MO diagrams; | **Reading:**Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd 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., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991). |
| **Week 5** | 3.3. Valence shell electron pair repulsion theory (VSEPR). | **Reading:**Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991). |

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| | 3.4. explaining the shapes of inorganic molecules (i.e. $AB_2$, $AB_3$, $AB_2E$, $AB_4$, $AB_3E$, $AB_2E_2$, $AB_5$, $AB_4E$, $AB_3E_2$, $AB_2E_3$, $AB_6$, $AB_5E$, $AB_4E_2$) 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**<br>4.1.General concept of acids and bases. | **Reading:** Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2nd 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, 2nd 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, 2nd 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**<br>5.1 Electronic configuration and oxidation states of transition elements | **Reading:** Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992). |
| | 5.2. Metallurgy of chromium, nickel and copper. | **Reading:** Sharp, A.G. "Inorganic Chemistry", Longman, 3rd 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, 3rd Edition (1992). |

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| | 5.4. Nomenclature and Isomerism in coordination compounds. | **Reading:** Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992). |
| **Week 10** | 5.5.What are Chelates, nomenclature and functioning. | **Reading:** Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992). |
| | 5.6. Application of coordination compounds. | **Assignment:** Write a review on Atomic theories. |
| **Week 11** | **Unit 6 Nuclear Chemistry**<br>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**<br>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 Quantitave Chemical analysis", 5th |

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| | | 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 Quantitave Chemical analysis", 5th |
| **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 Quantitave Chemical analysis", 5th |
| | 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 Quantitave Chemical analysis", 5th |
| **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 Quantitave Chemical analysis", 5th |
| | 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, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3rd Edition (1995).
2. Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th Edition (1996).
3. Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991).
4. Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2nd Edition (1996).
5. Sharp, A.G. "Inorganic Chemistry", Longman, 3rd 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 Quantitave Chemical analysis", 5th 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. |

**University of the Punjab, Lahore**

# Course Outline

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| **Programme** | BS Science Education | **Course Code** | **SE-303L** | **Credit Hours** | 1 |
| **Course Title** | **CHEMISTRY LAB-II (INORGANIC CHEMISTRY LAB)** | | | | |

## Course Introduction

**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.**

## Learning Outcomes

On the completion of the course, the students will:

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**<br>Laboratory safety protocols, chemical handling, Experimentation protocols | **Reading:** Basics of solution preparation by Atkins, Chapter 1. |
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| **Week 2** | **Solution preparation**<br>Solution preparation, percentage solution, Normal solutions, Molar and Molal solutions, different concentration solutions. \ | **Reading:** Basics of solution preparation by Atkins, Chapter 1. |

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| **Week 3** | **UNIT 1 PAPER CHROMATOGRAPHY**<br>1.1. Preparation of standard molar and normal solutions; percentage compositions of different compounds. | **Reading:** Javed Iqbal, Amin, "Theory and Practice of chromatography", Higher Education Commission, Islamabad, (2002). |
| **Week 4** | 1.2. Separation & identification of cations/basic radicals of group I, II.A, II.B & III. Also calculate their Rf values. | Javed Iqbal, Amin, "Theory and Practice of chromatography", Higher Education Commission, Islamabad, (2002).<br>. |
| **Week 5** | **Unit-II ARGENTOMETRY**<br>**2.1 MOHR'S METHOD**<br>2.1. Determine the %age purity of NaCl (rock salt) | **Reading** Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994). |
| **Week 6** | 2.2. Determine the amount of NaCl in the commercial sample of soda ash. | **Reading** Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994). |
| **Week 7** | **Unit-III VOLHARD'S METHOD**<br>3.1. Determination of %age purity of HCl. | **Reading** Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994). |
| **Week 8** | 3.2. Determination of silver in the given sample, using KSCN or $NH_4SCN$ | **Reading** Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994). |
| **Week 9** | **Unit-IV REDOX TITRATIONS (By using both internal and external indicators)**<br>4.1. Determination of amount/$dm^3$ of $FeSO_4.7H_2O$ with $K_2Cr_2O_7$. | **Reading** Skoog, D.A., D.M. West and F.J. Holler, "Analytical Chemistry", 6th Edition, Saunders College Publications, (1994). |

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

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| 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. |

**University of the Punjab, Lahore**

# Course Outline

| Programme | BS Science Education | Course Code | SE-303A | Credit Hours | 04 |
|---|---|---|---|---|---|
| **Course Title** | Mathematics B-I [Vectors & Mechanics (I)] | | | | |

## Course Introduction

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.

## Learning Outcomes

On the completion of the course, the students will:

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

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| **Week 1** | **Unit -1:Vector Algebra**<br>1.1 Introduction to vector algebra |
| | 1.2 Scalar and vector product |
| **Week 2** | 1.3 Scalar triple product and vector triple product |
| | 1.4 Applications to geometry |
| **Week 3** | **Unit-2: Vector Calculus**<br>2.1 Limit, continuity and differentiability of vector point functions |
| | 2.2 Partial derivatives of vector point functions |

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| **Week 4** | 2.3 Scalar and vector fields |
| | 2.4 The gradient, divergence and curl |
| **Week 5** | 2.5 Expansion formulas. |
| | **Unit-3: Forces**<br>3.1 Fundamental concepts and principles |
| **Week 6** | 3.2 Inertial-non-inertial frames, Newton's laws |
| | 3.3 Resultant of several concurrent forces |
| **Week 7** | 3.4 The parallelogram law of forces |
| | 3.5 Resolution of a forces, triangle of forces |
| **Week 8** | 3.6 Lamy's theorem, polygon of forces |
| | 3.7 Conditions of equilibrium for a particle |
| **Week 9** | **MID- TERM EXAM** |
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| **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, Varigon'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**<br>4.1 Dry friction and fluid friction |
| **Week 14** | 4.2 Laws of dry friction, coefficients of friction, angle of friction |
| | 4.3 Equilibrium of a particle on a rough inclined plane |
| **Week 15** | 4.4 Particle on a rough inclined plane acted on by an external force |
| | 4.5 Conditions for sliding or titling |
| **Week 16** | **Unit-5: Virtual Work**<br>5.1 Principle of virtual work |
| | 5.2 Problems involving tensions and thrust |

**Textbooks and Reading Material**


**1.** Thomas, *Calculus,* 11th Edition. Addison Wesley publishing company, 2005

**2.** Jafferson, B. Beasdsworth, T. *Further Mechanics,* 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.
- I$^{st}$ assignment before mid-term exam.
- 2$^{nd}$ assignment after mid-term exam

**Assessment**

| Sr. No. | Elements | Weightage | Details |
|---|---|---|---|
| 1. | Midterm Assessment | | |
| 2. | Formative Assessment | | |

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| 3. | Final Assessment | | |