

**Course Name:** Inorganic Chemistry

3(2+1)

**Course Objectives:**

Students will acquire knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of p-block elements as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

**Course Content:**

**Chemical Bonding:**

Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion (VSEPR) model, molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding.

**Acids and Bases:**

Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB), concept of relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions, theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

**p-Block Elements:**

Physical and chemical properties of p-block elements with emphasis on some representative compounds, inter-halogens, pseudo-halogens and polyhalides.

**CHEM-151 Lab:**

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD), disposal of chemical waste and first-aid practices, qualitative analysis of salt mixtures, quantitative analysis, acid-base titrations, preparation and standardization of acid and alkali solutions, redox titrations, preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample, gravimetric analysis, determination of barium in a given sample, determination of chloride in a given solution.

### Recommended Books:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity*, 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., *Inorganic Chemistry*, Academic Press. USA, (2008).
5. Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3rd ed., Pearson Education, India, (2008).
7. Huheey, J. E., Keiter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., *Inorganic chemistry*, 3rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, *Inorganic Chemistry*, 3rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., *Descriptive Inorganic Chemistry*, 2nd ed., Brooks Cole, (2010).
12. Wulfsberg G., *Principles of Descriptive Inorganic Chemistry*, 1st ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., *Laboratory Safety for Chemistry Students*, John-Wiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., *Vogel's Textbook of Quantitative Chemical Analysis*, 6th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, 7th ed., (7th imp.), Pearson Education, Ltd., (2009).

**Course Name:** Organic Chemistry

3(2+1)

**Course Objectives:**

Students will acquire knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reactions. Such information will be useful for qualitative analysis and synthesis of organic compounds.

**Course Content:**

**Basic Concepts of Organic Chemistry:**

Bonding and hybridization, localized and delocalized bonding, structure-aromaticity, inductive effect, dipole moment, resonance and its rules, hyperconjugation, classification and nomenclature of organic compounds including IUPAC system, types of organic reactions (an overview).

**Chemistry of Hydrocarbons:**

Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and electrophilic substitution reactions.

**Chemistry of Functional Groups:**

Hydroxyl, ether and amino groups, preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications, carbonyl compounds, preparations and reaction mechanism of aldehydes and ketones and their applications, carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydrides.

**CHEM-161 Lab.**

Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

**Recommended Books:**

1. Brown, W. and Poon, T., *Introduction to Organic Chemistry*, 3rd ed., John-Wiley & Sons, Inc., (2005).

2. John, E. M. *Organic Chemistry*, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall, New Jersey, (1992).
4. Younus, M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).
5. Sykes, P., *A Guide Book to Mechanism in Organic Chemistry*, 6th ed., Pearson Education Limited, England, (1986).
6. Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry*, 10th ed., John-Wiley & Sons, Inc., (2011).
7. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5th ed., Longman, UK, (1989).
8. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques*, 5th ed., Brooks/ Cole Cengage Learning, (2013).
9. Mayo, D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic to Laboratory with Multistep and Multisacle Syntheses*, 5th ed., John-Wiley & Sons, Inc., (2011).
10. Gilbert, J. C. and Martin, S. F., *Experimental Organic Chemistry: A Miniscale and Microscale Approach*, 5th ed., Brooks/ Cole Cengage Learning, (2010).
11. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry*, 6th ed., Brooks/ Cole Cengage Learning, (2012).

**Course Name:** Physical Chemistry

3(2+1)

**Course Objectives:**

Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibria and to investigate the physical properties of ideal/non-ideal binary solutions. Students will also be able to study the rates of reactions and perform related calculations.

**Chemical Thermodynamics:**

Equation of states, ideal and real gases, the virial equation and the van der Waals equation for real gases, critical phenomena and critical constants, four laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes, spontaneous and non-spontaneous processes, relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity.

**Chemical Equilibrium:**

General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van't Hoff equation, Le-Chatelier's principle.

**Solution Chemistry:**

Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and non-ideal solutions, Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions and Henry's law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.

**Chemical Kinetics:**

The rates of reactions, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, experimental techniques for rate determination and methods for determination of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

### **CHEM-171 Lab.**

1. Determination of viscosity and refractive index of liquids.
2. Determination of percent composition of liquid solutions viscometrically.
3. Determination of refractive index and molar refractivity.
4. Determination of percent composition of liquid solutions by refractive index measurements.
5. Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
6. Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
7. Determination of heat of solution by solubility method.
8. Determination of heat of neutralization of an acid with a base.
9. Kinetic study of acid catalyzed hydrolysis of ethyl acetate.
10. Determination of partition coefficient of a substance between two immiscible liquids.

### **Recommended Books:**

1. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1st ed., University Science Books, (1997).
2. Atkins, P. and Paula, J. D., Atkins's Physical Chemistry, 9th ed., Oxford University Press, (2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).
5. Glasstone, S., *Textbook of Physical Chemistry*, Macmillan London (1960).
6. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York, (1974).
7. Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana, Lahore, (2013).
8. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
9. Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Pvt. Ltd., (2011).

**Course Name:** Biochemistry

3(2+1)

**Course Objectives:**

Students will gain knowledge about fundamental concepts of biochemistry as well as be able to learn about the structures, properties and functions of amino acids, proteins, carbohydrates, lipids and nucleic acids.

**Introduction to Biochemistry:**

Brief introduction to the scope and history of Biochemistry, molecular logic of the living organism, cell structures and their functions, origin and nature of biomolecules.

**Acid–Base and Electrolyte Chemistry:**

Intracellular and extracellular electrolytes, body fluids as electrolyte solutions, pH, Henderson-Hasselbalch equation and buffers, amino acids, peptides and proteins, buffer capacity, buffers of body fluids, haemoglobin as an acid-base system, renal control of acid-base, balance, acid-base disorders: acidosis, alkalosis. haemoglobin and omeostasis, variation of Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup> in acid-base disturbances.

**Carbohydrates, Lipids and Proteins:**

Definition and classification, chemistry, physical and chemical properties of various classes of carbohydrates, biological functions of starch, glycogen, cellulose, and cell wall polysaccharides, acid mucopolysaccharides and proteoglycans.

Definition and classification of lipids, chemistry and biological importance of fatty acids, waxes, glycerides, phospholipids, sphingolipids, glycolipids, sterols and prostaglandins.

Significance of lipids in biological membranes and transport mechanism.

Chemistry and classification of amino acids, physical and chemical properties of amino acids, biological significance of amino acids, peptides, proteins, their classification, properties and biological significance, primary, secondary tertiary and quaternary structure of proteins, denaturation of proteins.

**Nucleic Acids:**

Chemical composition of nucleic acids, structure and biological significance of nucleic acids, chemical synthesis of oligonucleotides, nucleic acids hydrolysis, isolation and separation of nucleic acids, introduction to recombinant DNA technology.

**CHEM-131 Lab.**

Qualitative and quantitative analysis of carbohydrates, lipids and proteins.

Laboratory work illustrating topics covered in the lecture of Chem.131, Determination of pH, Preparation of buffers.

Enzyme catalysis, Progress curve for enzyme catalyzed reactions, Determination of values. To study the effect of different factors on the rate of enzyme catalyzed reactions.

**Recommended Books:**

1. R. C. Alkire, D. M. Kolb, J. Lipkowski, *Biselectro chemistry, volume 13*, 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
2. Nelson,D.L., *Lehninger's Principles of Biochemistry*, 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
3. Voet, D. and Voet, J.D., *Biochemistry*, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
4. Murray, R.M. and Harper, H.A., *Harper's Biochemistry*, 25th ed., Publisher:Appleton& Lange, (2000). ISBN: 0838536840, 9780838536841.
5. Zubay, G. L., *Biochemistry*, 4th ed., illustrated, Publisher W. M. C. Brown Publishers, (1998), Digitized (2008). ISBN: 0697219003, 9780697219008.
6. Guyton, A. C. & Hall, J. E., *Guyton & Hall Textbook of Medical Physiology*, 12th ed., Publishers: Saunders Elsevier, (2011). ISBN: 978-1-4160-4574-8.
7. Harvey, R. A., Ferrier, DR, Karandish S., *Lippincott's illustrated Reviews: Biochemistry*, 5th ed., and *Biochemistry Map (Med maps)* Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.



**Course Name:** Analytical Chemistry

3(2+1)

**Course Objectives:**

Students will acquire knowledge about sampling and their handling and preparation and results calculation and data reporting. In addition they will learn and develop understanding about the classical techniques of analytical chemistry and quality control and quality assurance

**Course Contents:**

**Chemometrics:**

Sampling, significant figures, stoichiometric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard deviation/relative standard deviation, confidence limits, Gaussian distribution, least square method, tests for significance, outliers

**Quality Control and Quality Assurance:**

Definitions, seven tools for quality control, the concept of quality assurance, quality assurance techniques, validations based on design qualification (DQ), installation qualification (IQ), operational qualification (OQ) and performance qualification (PQ), calibrations, monitoring and quality reviews, periodical trainings, six sigma concept, ISO standards.

**Classical Analytical Methods:**

Acid-base, complexometric and redox titrations, gravimetric analysis.

**CHEM-111 Lab.**

Calibration of volumetric glassware, electronic and analytical equipment, statistical evaluation of analytical data including linear regression analysis, constructing a calibration curve from a given analytical data using spread sheet software, determination of hardness of water using EDTA, determination of chloride in tap water sample, estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry, gravimetric analysis, determination of barium in barium nitrate, determination of nickel in a given steel sample, determination of bicarbonates in a clinical sample using back-titration, determination of cation in a mixture by complexometric titration, studying the effect of common ions on solubility of sparingly soluble salts (e. g. AgCl / PbSO<sub>4</sub>).

**Recommended Books:**

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9th ed., Brooks Cole Publishing Company, (2013).
2. Christian, G. D., *Analytical Chemistry*. 6th ed., John-Wiley & Sons, New York, (2006).

3. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, USA, (2011).
4. Kealey, D. and Haines, P. J., Instant Notes., *Analytical Chemistry*, Bios Scientific Publishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, *CHEMOMETRICS-Statistics and Computed applications in Analytical Chemistry*, 2nd ed., Wiley-VCH, Germany, (2007).
6. Mitra A., *Fundamentals of Quality Control and Improvement*, 3rd ed., John-Wiley & Sons, (2008).
7. Miller, J. and Miller, J., *Statistics and Chemometrics for Analytical Chemistry*, 5th ed., Prentice Hall, (2005).