

## M.Sc. (Chemistry) Programme

M.Sc. programme consists of two parts namely Part-I and Part-II. The Scheme of study, Syllabi and Courses of Reading for the M.Sc. (Chemistry) Part-I and Part-II are given below:

### M.Sc. (CHEMISTRY) ANNUAL SYSTEM (2 YEARS PROGRAM)

#### M.Sc. (Part-I)

<b>Paper No.</b>	<b>Title</b>
Paper-I	Physical Chemistry (written)
Paper-II	Inorganic Chemistry (written)
Paper-III	Organic Chemistry (written)
Paper-IV	One of the following to be opted or allotted (i) Biochemistry (written) OR (ii) Analytical Chemistry (written) OR (iii) Applied Chemistry (written)
Paper-V	Physical Chemistry (practical)
Paper-VI	Inorganic Chemistry (practical)
Paper-VII	Organic Chemistry (practical)
Paper-VIII	(i) Biochemistry (practical) OR (ii) Analytical Chemistry (practical) OR (iii) Applied Chemistry (practical)

#### M.Sc. (Part-II)

In M.Sc. Part-II the student will opt or be allotted one “**major subject**” out of the following: (which he / she studied in M.Sc. Part-I)

- A. **Physical Chemistry**
- B. **Inorganic Chemistry**
- C. **Organic Chemistry**
- D. **Biochemistry**
- E. **Analytical Chemistry**
- F. **Applied Chemistry**

## M.Sc. (Chemistry)

The papers to be studied in Part-II will be as follows:

Paper-I	Special Paper (written)	(of the major subject)
Paper-II	Additional Paper (written)	(of the major subject)
Paper-III	Practical	(of the major subject)
Paper-IV	Environmental Chemistry	(Compulsory for every student)
Paper-V	Research (Thesis) or Elective Paper	

The numbering of papers in various major subjects would be as follows:

Paper I-A	Physical Chemistry (Special)
Paper II-A	Physical Chemistry (Additional)
Paper III-A	Physical Chemistry (Practical)
Paper I-B	Inorganic Chemistry (Special)
Paper II-B	Inorganic Chemistry (Additional)
Paper III-B	Inorganic Chemistry (Practical)
Paper I-C	Organic Chemistry (Special)
Paper II-C	Organic Chemistry (Additional)
Paper III-C	Organic Chemistry (Practical)
Paper I-D	Biochemistry (Special)
Paper II-D	Biochemistry (Additional)
Paper III-D	Biochemistry (Practical)
Paper I-E	Analytical Chemistry (Special)
Paper II-E	Analytical Chemistry (Additional)
Paper III-E	Analytical Chemistry (Practical)
Paper I-F	Applied Chemistry (Special)
Paper II-F	Applied Chemistry (Additional)
Paper III-F	Applied Chemistry (Practical)

In M.Sc. Part-II students will be divided into two streams **1)** who are offered 100 marks research thesis (about 40%). **2)** who are offered 100 marks as special paper “elective subject” (about 60%). The students will not have any right to opt for any of three (1) Research thesis (2) Dissertation and (3) Special paper unless otherwise awarded by the Institute.

Those students who would not be allotted research (due to lack of facilities in the Institution) will opt / be allotted an “**elective subject**” instead of research and as an



**M.Sc. (Part-I)****Physical Chemistry (Written) Paper – I****SYLLABUS OUTLINE:****1. Electrochemistry:**

Idea of conductance of electrolytes, Debye-Huckel equation and limiting law, ionic strength, weak electrolyte and Debye-Huckel theory, Activity and activity coefficients of electrolytic solution, determination of activities, concentration cells, Types of concentration cells, derivation of E.M.F of concentration cells with and without transference, Fuel cells and hydrocarbon cells.

**2. Quantum Chemistry:**

Postulates of quantum theory, Eigen functions, operators, Schrödinger's wave equation, particle in one dimensional box, Normalized wave function and orthogonality, Quantum mechanical tunneling, motion of particle in three dimensional box and idea of degeneracy, separation of variables and derivation of quantum numbers, Mathematical treatment of rigid rotator and calculation of bond length of simple molecules, harmonic oscillator and calculation of bond length of simple molecules, harmonic oscillator and calculation of vibrational frequencies, formation of covalent bond, Mathematical treatment of  $\text{He}^+$  and  $\text{H}_2$  molecules, discussion of overlapping integrals, molecular orbital theory and formation of  $\text{H}_2$  and  $\text{O}_2$  molecules.

**3. Chemical kinetics:**

Concept of rate law and order of reaction, Kinetics of 3rd order reaction with different concentrations and molecular identity, kinetics of opposing, parallel and consecutive reactions, basic experimental methods, Kinetics of thermally excited chain reactions like reaction of  $\text{H}_2$  and  $\text{Br}_2$ , kinetics of thermal decomposition of ozone,  $\text{N}_2\text{O}_5$  and  $\text{CH}_3\text{CHO}$ .

**4. Kinetics of bimolecular reactions:**

Mathematical treatment of collision and transition state theory of bimolecular reactions, effect of temperature of reaction rates, the interpretation of bimolecular reactions in solution, ionic reaction in solution, unimolecular gas phase reactions, fast reactions and their methods of study.

**5. Classical Thermodynamics:**

Maxwell's relations and thermodynamics formula, second law of thermodynamics, Clausius inequality, the entropy of non ideality of a gas, Nerst heat theorem, its applications to solid and gases, Nerst approximation formula, third law of thermodynamics and determination of entropy by third law, Experimental verification of third law. Adiabatic demagnetization.

**6. Statistical Thermodynamics:**

Sterling's approximation, statistical treatment of entropy, partition function and its physical significance, absolute entropy and partition functions, interpretation of thermodynamic functions in terms of translational, rotational vibrational and

electronic partition functions, Free energy and equilibrium constant from partition function.

**7. Kinetic theory of Gases:**

Introduction, Maxwell distribution of molecular velocities and energies, Derivation of average velocity and most probable velocity, Barometric formula, effect of altitude, molar mass and temperature on vertical distribution of particles.

**Note Suggested out lines for Mathematics Course:  
Basic Mathematics for Chemistry (1 Credit Course):**

Review of basic algebra and trigonometry, concept of function, Differentiation, concept of maxima and minima, integration, Differential Equations, equations of straight lines, partial fraction, Applications of Calculus in Chemistry and data handling.

**RECOMMENDED BOOKS:**

1. Physical Chemistry, Samuel Glasstone, 1995. Macmillan and Co. Ltd. St. marlins Street, London.
2. Principles of Physical chemistry, Maron and Prutton, 1965 the Macmillan Company, Collier Macmillan Ltd. London.
3. Physical Chemistry, Barrow, 1973, McGraw Hill, Tokyo.
4. Physical Chemistry, Moore, 1972, Rentice Hall, Englewood cliffs, Jersey.
5. Physical Chemistry, Alberty and Daniels, 1962, McGraw Hill Book Company Ltd London.
6. Physical Chemistry, Castellan, 1972, Addison Westey Publishing Company, Menla Park, California, London.
7. Physical Chemistry by Kundu, N and Jain, S.K., S. Chand and Company Ltd. 1984.
8. Fundamentals of Chemical kinetics by Logan, S.R., Longman Group Ltd. 1996.
9. Elementary reaction kinetics by Latham. J.L. and Burgess, A.E., 3rd Ed., Butterworths, London, 1997.
10. Physical Chemistry by Atkins, P.W., 5th Ed., W.H. Freeman and Company, New Yark, 1994.
11. Physical Chemistry by Alberty, R.A. and Silbey, R.J., John Wiley, New York, 1995.
12. Physical Chemistry by Engel, T. and Ried, P., 1st Ed., Pearson education, Inc. 2006.
13. Electrochemical Methods and applications by Bard, A. and Faulkner, L.R., John Wiley, New York, 1980. Elements of classical and statistical thermodynamics by Nash, L.K. Addison Wesley Co. Ltd., 1979.
14. Hand book of surface and Colloid Chemistry by Birdi, K.S., CRC Press, 1997.
15. Heterogeneous Catalysis: Principles and applications by Bond, G.C., 2nd Ed., Oxford, Clarendon press, 1987.
16. Surfactants and interfacial Phenomena by Rosen, Milton J., John Wiley, New York, 1978.

**Physical Chemistry (Practical) Paper – V****SYLLABUS OUTLINE:****1. Basic Concepts:**

Preparation of standard molar and Normal solutions and percentage compositions of different compounds.

**2. Chemical Kinetics:**

To investigate the kinetics of hydrolysis of ethyl in the presence of an acid.

To determine the relative strength of acids (HCl and H<sub>2</sub>SO<sub>4</sub>) studying the hydrolysis of an ester.

**3. Electric conductance of electrolytes:**

To determine the cell constant of given cell.

To determine the equivalence conductance of solution of weak electrolyte.

At a no. of dilution at room temperature and from this result to verify Oswald's law.

To determine the solubility of sparingly soluble salt.

To determine the solubility of weak base of NH<sub>4</sub> OH by titrating it against Standard solution of HCl by using conductivity method.

To determine the strength of given base by titrating it against standard Acetic acid solution and HCl solution using conductivity meter.

To determine the strength of HCl and CH<sub>3</sub> COOH in the given mixture of both by titrating it against NaOH conductometrically.

To determine the equivalent conductance of a weak electrolyte at infinite dilution using Kohlraush law.

**4. Phase Equilibria:**

To determine the partition coefficient of benzoic acid and iodine between CCl<sub>4</sub> and H<sub>2</sub>O.

**5. Refractometry:**

To determine the unknown concentration of sucrose solution and ethanol solution.

**6. Molar mass determination (Colligative properties):**

To determine the molecular weight of a substance by cryoscopic method and Ebullioscopic method.

**7. Spectrophotometry:**

To determine the wavelength of maximum absorption of compounds using spectrophotometer.

To determine the unknown concentration of a compound using spectrophotometer.

**8. Phase Equilibrium:**

To determine the phase diagram of Naphthalene and diphenyl system.

To determine the phase diagram of urea and phenol.

To determine the phase diagram of Benzoic acid and Naphthalene.

**9. Optical activity measurement:**

To determine the unknown percentage composition of the following by using polarimeter (Sucrose, glucose).

To determine the specific and molar rotation of optically active compound (sucrose, glucose).

**RECOMMENDED BOOKS:**

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Matthews.
4. Experiments in Physical Chemistry by Shoemaker.

**M.Sc. (Part-II)**

**Physical Chemistry (Special Written) Paper I-A**

**SYLLABUS OUTLINE:**

**1. Colloids and Surfactants:**

Colloids, Colloidal dispersions, sols and their preparation, properties of suspensions, Optional properties of sols, determination of particle size, kinetic properties of sols, sedimentation of suspensions, electrical properties of sols, electrophoresis and electro osmosis, stability of suspensoids, precipitation of sols, associated colloids, macromolecular properties in solutions and molecular weight determinations.

**2. Advance approach to homogenous and heterogeneous kinetics:**

Adsorption isotherms, single system, double system, study of gas reactions on solid surfaces, retardation, the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism to study some organic and inorganic reactions, Catalysis, Autocatalysis, enzyme catalysis and enzyme inhibition.

**3. Nuclear Chemistry:**

Composition of the nucleus, natural and artificial radioactivity, rate of radioactive disintegration, radioactive equilibrium, transformation of elements cyclotron and linear accelerators; nuclear processes; nuclear fission, atomic bomb, nuclear reactor, nuclear fusion, hydrogen bomb, stellar energy, radiation hazards, use of tracers in chemistry.

**4. Advance Approach to Osmosis and Osmotic Pressure:**

Semi Permeable membranes. The cause of semi-permeability. Mechanism of osmotic pressure. Dilute solutions and the Gas Laws. The Bombardment theory. Objections to the Bombardment theory. Review of the theories. Determination of the molecular weight by Osmometry.

**5. Gels and Emulsions:**

Introductions, Methods of Preparation of Emulsions. Emulsifiers, Breaking of emulsions. Orientation Theory. Emulsification and wetting, Significance.

**RECOMMENDED BOOKS:**

1. Physical Chemistry by Alberty, R.A. and Silbey, R.J., John Wiley, New York, 1995.
2. Physical Chemistry by Engel, T. and Ried, P., 1st Ed., Pearson education, Inc. 2006.
3. Electrochemical Methods and applications by Bard, A. and Faulkner, L.R., John Wiley, New York, 1980.
4. Elements of classical and statistical thermodynamics by Nash, L.K. Addison Wesley Co. Ltd., 1979.
5. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
6. Fundamentals of chemical kinetics by Logan, S.R, Longman Group Ltd. 1996.
7. Elementary reaction kinetics by Latham.J.L. And Burgess, A.E.3rd Ed., Butterworths, London, 1977.
8. Heterogeneous Catalysis: Principles and applications by Bond, G.C., 2nd Ed., Oxford, Clarendon press, 1987.
9. Physical Chemistry, Samuel Glasstone, 1995. Macmillan and Co. Ltd. St. marlins Street, London.
10. Principles of Physical chemistry, Maron and Prutton, 1965 the Macmillan Company, Collier Macmillan Ltd. London.
11. Physical Chemistry, Barrow, 1973, McGraw Hill, Tokyo.
12. Physical Chemistry, Moore, 1972, Rentice Hall, Englewood cliffs, Jersey.

**Physical Chemistry (Additional Written) Paper II-A****SYLLABUS OUTLINE:****1. Rotational and Vibrational Spectroscopy**

Special regions and classification of spectroscopy; Rotational energies of diatomic molecules, population of Rotational energy level. Rotational spectra of rigid linear molecules and determination of bond lengths. The Stark effect.

Vibrational spectroscopy: energy of an atomic molecule, harmonic and anharmonic oscillator molecules, relative population of energy levels and intensities of transition, types of vibrational modes.

Vibrational of polyatomic molecules, interpretation of IR spectra of simple molecules, Fermi resonance, applications and sampling techniques.

**2. Photo Chemistry:**

Laws of photochemistry, quantum efficiency and its determination Photochemical reactions, excited state symbols; photosensitized reactions, phosphorescence, fluorescence, chemiluminescence, Lasers.

**3. Advanced Treatment of Solutions:**

The thermodynamic properties of solution. The solution process. Conditions of equilibrium between phases. Theoretical basis of Raoult's equation. Deviation from ideal behavior. Compound formation and association. Separation of solid solutions.



**4. Polymers:**

Classification of polymers; kinetics of condensation, addition and co-polymerisation reactions; Molecular mass distribution, determination of molecular masses by different methods. Analysis techniques.

**5. Electronic and Raman Spectroscopy:**

Principles of electronic transition. Types of electronic transition. Energies of atomic orbital-with reference of H-atom spectrum electronic angular momentum fine structure of H-atom spectrum.

Raman Spectra-idea of Raman scattering, Rayleigh scattering Molecular polarizability. Rotational Raman Spectra of linear Molecules. Symmetric top molecules and spherical top molecules Vibrational Raman spectra.

**RECOMMENDED BOOKS:**

1. Physical Chemistry, Castellan, 1972, Addison Westey Publishing Company, Menlo Park, California, London.
2. Physical Chemistry by Kundu, N and Jain, S.K., S. Chand and Company Ltd. 1984.
3. Fundamentals of Chemical kinetics by Logan, S.R., Longman Group Ltd. 1996.
4. Elementary reaction kinetics by Latham. J.L. and Burgess, A.E., 3rd Ed., Butterworths, London, 1997.
5. Physical Chemistry by Atkins, P.W., 5th Ed., W.H. Freeman and Company, New York, 1994.
6. Physical Chemistry by Alberty, R.A. and Silbey, R.J., John Wiley, New York, 1995.
7. Physical Chemistry by Engel, T. and Ried, P., 1st Ed., Pearson education, Inc. 2006.
8. Electrochemical Methods and applications by Bard, A. and Faulkner, L.R., John Wiley, New York, 1980.
9. Elements of classical and statistical thermodynamics by Nash, L.K. Addison Wesley Co. Ltd., 1979.
10. Fundamentals of chemical kinetics by Logan, S.R., Longman Group Ltd. 1996.
11. Elementary reaction kinetics by Latham. J.L. and Burgess, A.E. 3rd Ed., Butterworths, London, 1977.
12. Physical Chemistry, Samuel Glasstone, 1995. Macmillan and Co. Ltd. St. marlins Street, London.
13. Principles of Physical chemistry, Maron and Prutton, 1965 the Macmillan Company, Collier Macmillan Ltd. London.
14. Physical Chemistry, Barrow, 1973, McGraw Hill, Tokyo.
15. Physical Chemistry, Moore, 1972, Rentice Hall, Englewood cliffs, Jersey.

**Physical Chemistry (Practical) Paper III-A****SYLLABUS OUTLINE:****1. Molecular Mass Determination of different Polymers by Viscosity measurement.****2. Thermo-chemical measurements**

- (i) Heat of solution of a salt by solubility methods.
- (ii) Heat of precipitation.

**3. Colloidal State:**

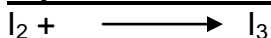
Preparation of  $As_2 S_3$  sol, and comparison of precipitating powers of different cations.

**4. Spectrophotometry:**

- (i) Determination of percentage composition of two coloured components in solution.
- (ii) Study of kinetics of iodination of acetone and decomposition of benzene diazonium chloride.
- (iii) Predicting normal modes of vibration for simple molecules and interpretation of their IR Spectra.

**5. Polarimetric Study of Reaction Kinetics:**

Inversion of cane sugar; salt effects on inversion of cane sugar.

**6. Equilibrium constant for the reaction:**

Calculation of  $\Delta G$  for the formation of  $I_3^-$  reaction.

**7. Adsorption measurements:**

Verification of Freundlich and Langmuir adsorption isotherms for Adsorption of acetic acid on active charcoal.

**8. Potentiometric measurements:**

- A. Potentiometric Titrations
  - (i) Acid base
  - (ii) Oxidation-reduction
- B. Equilibrium constant determination.

**RECOMMENDED BOOKS:**

- 1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
- 2. Experimental Physical Chemistry by Daniel
- 3. Experimental Physical Chemistry by G.Peter Matthews.
- 4. Experiments in Physical Chemistry by Shoemaker.

**M.Sc. (Part-I)****Inorganic Chemistry (Written) Paper - II****SYLLABUS OUTLINE:****1. Pi- acceptor Ligands:**

Transition metal carbonyls (Mononuclear, Binuclear, Polynuclear), synthesis, bonding situation based on spectroscopic evidences; Theoretical rationalization of molecular structures, (close, nido, erachno), Synthesis. Characteristics and reactivity of derivatives of metal carbonyls (carbonylate anions, carbonyl hydrides and carbonyl halides); Metal nitrosyls including halonitrosyl and their derivatives.

**2. Chemical bonding:**

Metallic bond on the basis of band model, X-ray spectra and  $N(E)$  curves,  $n(E)$  curves. Binding energy in metals, conductors, semi-conductors and insulators. Effect of temperature and impurities on conductivity.

**3. Coordination Compounds: (Structure & Bonding)**

Development of coordination compounds, Rules of inorganic nomenclature for acids, salts, radicals, ions, iso and heteropoly anions & compounds. Hybridization in coordination compounds with coordination number from 2 to 9. MO diagrams for metal complexes of common geometry. Important features of CFT, d-orbitals splitting for various common geometries, measurement of  $10 Dq$ , factors effecting  $10 Dq$ . CFSE, factors influencing magnitude of variation in lattice and hydration energy for ions of first transition series.

**4. The Covalent Bond (Structure & Reactivity):**

- (a) VSEPR model followed by VB theory (Hybridization, Resonance etc.) explanation of the structure of  $AB_2$ ,  $AB_3$ ,  $AB_2E$ ,  $AB_4$ ,  $AB_3E$ ,  $AB_2E_2$ ,  $AB_5$ ,  $AB_3E_3$ ,  $AB_6$ ,  $AB_5E$ ,  $AB_4E_2$ ,  $AB_7$ ,  $AB_6E$ ,  $AB_8$  and  $AB_9$  type molecules.
- (b) Discussion of molecular orbitals and molecular structures of homonuclear molecules and ions, heteronuclear diatomic and polyatomic molecules and ions.
- (c) Bent bond, bridge bond, four electrons-three centre bond.
- (d) Shielding effect and effective nuclear charge, Factors affecting the magnitude of  $\sigma$  and  $Z_{\text{eff}}$  and their variation in the period table, Applications of Slater's rules, Polarization of ions, Fajan's rules and its applications.

**5. Co-ordination compounds: (synthesis and properties)**

Preparative methods. Techniques of studying complexes, stability constants. The spectrochemical series and colour of metal complexes. Diamagnetism and Paramagnetism, stereochemistry, John-Teller Theorem, Isomerism. Role of metal complexes in analytical chemistry, industry and nature.

**6. Chemistry of the Lanthanides and Actinides**

Nomenclature, Position in periodic table, occurrence, Separation, and electronic configuration, oxidation States, Complex Formation, shapes of 'f'-orbitals, applications.

**RECOMMENDED BOOKS:**

1. J H Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (2008)
2. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
3. Introduction to Chemical Nomenclature by R.S. Cahn and O.E. dermer 2001. Butterworth (London).
4. Stereochemistry and bonding in Inorganic Chemistry by J.E. Ferguson 2001, Prentice Hall, New Jersey.
5. Chemical Bonds, and introduction to atomic and molecular structure by H.B. Gray 1973, W.A. Benjamin, Inc., London
6. Advanced Inorganic Chemistry F.A. Cotton and G.Wilkinson 6th Ed. 2001, Interscience, Publishers, London.
7. Coordination Compounds by S.F.A. Kettle, 1999, Nelson , (Nairobi Kenya).
8. Coordination Chemistry by B.A. Basallo and R. Johnson 1972 W.A. Benjamin, London.

**Inorganic Chemistry (Practical) Paper - VI****SYLLABUS OUTLINE:****1. Chromatographic Techniques:**

- (a) Separation of metal ions by paper chromatography and their identification with the help of locating agents and comparison of  $R_f$  values.
- (b) Separation of anions by paper chromatography and their identification.

**2. Aqueous acid-base Titrations:**

- (a) Estimation of  $\text{SO}_2$  and  $\text{SO}_3$  in air and discharged from an industrial process.
- (b) Estimation of  $\text{CO}_2$
- (c) Estimation of oxalic acid and  $\text{H}_2\text{SO}_4$  in a mixture.
- (d) Estimation of  $\text{H}_3\text{BO}_3$  and  $\text{NaH}_2\text{BO}_3$  in a mixture.
- (e) Determination of %age composition of a mixture containing  $\text{H}_3\text{BO}_3$  and  $\text{CH}_3\text{COOH}$ .

**3. Precipitation Titrations:**

Estimation of following anions with the help of adsorption indicators:

- (i) Chloride (ii) Bromide (iii) Sulphate (iv) Chloride and Iodide in a mixture.

**4. Complexometric Titrations:**

- (a) Estimation of  $\text{Mg}^{+2}$   $\text{Zn}^{+2}$  with EDTA (Direct titration).
- (b) Estimation of  $\text{Ni}^{+2}$  with EDTA (Back titration).
- (c) Determination of  $\text{Ca}^{+2}$  and  $\text{Zn}^{+2}$  in mixture (Masking)
- (d) Determination of  $\text{Cd}^{2+}$  and  $\text{Zn}^{+2}$  in a mixture (Demasking).

(e) Determination of  $\text{SO}_4^{2-}$  and  $\text{PO}_4^{3-}$  with EDTA (Indirect titration).

**5. Redox Titrations:**

(a) Use of Ceric sulphate solution for the estimation of the following:-

- i). Determination of iron in an iron ore.
- ii). Determination of nitrites.

(b) Use of potassium iodate for the determination of the followings:

- (i) Copper
- (ii)  $\text{H}_2\text{O}_2$
- (iii) Commercial Hypochlorite

**6. Preparations:**

- (a) Tris (ethylenediamine ) nickle (II) Chloride 2-hydrate.
- (b) Sodium Cobaltinitrite.
- (c) Pot. Trioxalato Aluminate.
- (d) Ammonium sulphate Nickel (II) Sulphate.
- (e) Hexa aqua Chromium (III) Chloride.
- (f) Ammonium Sulphate Copper (II) Sulphate Pentahydrate.

**RECOMMENDED BOOKS:**

1. J. Bassett, R. C. Denny, G. H. Jeffery and J. Mendham, Vogel's Text Book of qualitative Inorganic Analysis, the English Language Book Society and Longman, New York, (2008)
2. Quantitative Analysis Chemistry, James S. Pritz, George H. Sehenk, 2001 Alby and Becon Inc. London.
3. Theory and practice of chromatography by Prof. Dr. Javed Iqbal (2002).
4. Instrumental analysis by Gary D. Christian and James E.O., Reilly, 2007, Allyn and bacon Inc., London.
5. Hand Book of Organic reagents in Inorganic Analysis by ZAVIX Holzbecher and other 1976 Ellis Hurwod Limited, London.
6. Experimental Inorganic Chemistry - W. G. Palmer, 2005.
7. The analysis of minerals and ores of the rarer elements – W. R. Schoeller, and A. R. Powell, Charles, Griffin and Company Limited, 2004.

**M.Sc. (Part-II)****Inorganic Chemistry (Special Written) Paper I-B****SYLLABUS OUTLINE:****1. Stereochemistry and bonding in main group compounds:**

Introduction, directed valence theory, three center bond model, correlation diagram approach, some qualitative failures of the simple theories criticism and comparison of simple models,  $d\pi$ - $P\pi$  bonds.

**2. Periodicity:**

First and second row anomalies. The use of d-orbitals by non-metals, reactivity and d-orbital participation. The use of p-orbitals in  $\pi$ -bonding, periodic anomalies of the non-metals and post-transition metals.

**3. Organic Reagents used in Inorganic Analysis:**

Classification of organic reagents, their selectivity and specificity, methods of preparation of specific compounds and their studies with UV, Visible and IR. Typical reagents used in complexometric titrations involving the use of EDTA. Chelates, classification, stability, preparation and properties. Role of organic Reagents in different analytical techniques.

**4. Polymeric Inorganic Compounds (Chains, Rings and Cages):**

(a) Chains: Catenation, Homocatenation, Heterocatenation, Silicones, Silicates, Zeolites, talc, mica, clay.

(b) Rings: (i) Heterocyclic systems of borazines, Phosphazenes, S-N rings.  
(ii) Homocyclic system of sulphur and selenium.

(c) Cages compounds of phosphorus, and boron

(d) Inorganic Polymers as Conductors.

**5. Advances in Atomic Spectroscopy and Radio Chemistry:**

Various forms of interaction of electromagnetic radiation with matter, absorption and emission spectra. Flame photometer. Atomic absorption spectrophotometer, Inductively coupled plasma emission, Applications in clinical chemistry, industry, geochemistry, soil sciences and environmental studies.

**6. Some Thermodynamic aspects of Inorganic Chemistry:**

Thermodynamic and kinetic stability, Interpretation of stability, Role of thermodynamics in interpretative chemistry, The lattice energy as a criterion of bond type, Quantitative uses of the lattice energy, The Kapustunskii equations, The

stabilization of high oxidation states by fluorine and oxygen, The stabilization of low oxidation states by large anions, Halogen exchange reaction, The stability of halides containing protonated bases.

## **Inorganic Chemistry (Additional Written) Paper II-B**

### **SYLLABUS OUTLINE:**

#### **1. Reactions in aqueous and non-aqueous solvents:**

Classification of solvents, types of reactions, the dielectric constant, solubilities, electrode potential and electromotive forces. Reactions in water and molten salts. Reactions in non-aqueous solvents, i.e. ammonia, sulphur dioxide, bromine trifluoride and hydrofluoric acid.

#### **2. Radioactivity:**

Natural radioactivity, Artificial radioactivity, types of radioactive rays, Saddy-Fajans and Russel group displacement law, Half life period of a radioactive substance, Disintegration constant K, Average life period, Radioactive equilibrium, Law of successive disintegration, Activity of a radioactive substance, Transmutation of elements, Artificial transmutation reactions induced by different bombarding projectiles, Applications of artificial transmutation reactions, Natural and artificial radioactive series.

#### **3. Chemistry of Oxides:**

Physical states and structures of oxides of the elements, covalent oxides, periodic trends in structure and physical state, acidity, solubility, practical uses, and environmental chemistry of volatile oxides, close packed anions, metal oxides, electrical conductivity of solid ionic compounds, spinels, perovskites, high temperature superconductors, magnetic properties in mixed metal oxides.

#### **4. Kinetics and mechanisms of Reaction of Coordination Compounds:**

Introduction of reaction rate law and mechanism of stationary state approximation. Type of reactions, nucleophilic displacements, effective collisions. Displacement in square planar complexes, trans-effect, replacement in octahedral complexes, inert and labile complexes, (VBT, CFT explanation), Inner and outer sphere exchange reactions.

#### **5. Inorganic Chemistry in Biological systems:**

Energy sources for life, metalloporphyrins. Photosynthesis and respiration. Nitrogen fixation, the biochemistry of Iron essential and trace elements in biological systems biochemistry of the nonmetals medicinal chemistry organometallic in bio Inorganic Chemistry.

#### **6. Organo Metallic Compounds: **(Synthesis, Structure, Bonding & Reaction Pathways)****

Nature of carbon-metal bond, classification, synthesis and properties of organometallic compounds ( $\sigma$ -bonded olefin,  $\pi$ -allylic,  $\pi$ -cyclopentadienyl,  $\pi$ -organometallic compounds) and characterization of organometallic compounds with the help of IR, NMR, mass spectrometry etc. Experimental techniques in Organometallic chemistry

oxidative-addition, reductive elimination, insertion and de-insertion reactions, fluxional behaviour. Applications of organometallic compounds.

### **RECOMMENDED BOOKS:**

1. Organotransition metal Chemistry by Akin Yamamoto, 1996, A. Wiley Interscience Publication London.
2. Hand Book of Organic reagents in Inorganic Analysis by ZAVIX Holzbecher and other 1976 Ellis Hurwod Limited, London.
3. Structural Inorganic Chemistry by Wells, A.F. 1975, Charenden Press, London.
4. Stereochemistry and bonding in Inorganic Chemistry by by J.E. Ferguson 1974, Prentice Hall, New Jersey.
5. J H Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (2008)
6. Cullen Dolphin and James, Biological aspects of Inorganic Chemistry, 2005
7. Williams, An Introduction to Bioinorganic Chemistry, 2003

## **Inorganic Chemistry (Practical) Paper III-B**

### **SYLLABUS OUTLINE:**

#### **1. Use of organic reagents for the estimation of various metal ions:**

**(At least any four of the following):**

- (a) 8-Hydroxyquinoline ( $Al^{3+}$ ,  $Ti^{3+}$ ,  $Fe^{3+}$ )
- (b) Pyrogallol ( $Bi^{3+}$ )
- (c) Nitron ( $NO_3^{1-}$ )
- (d) Salicyladoxime ( $Ni^{2+}$  in presence of  $Cu^{2+}$ )
- (e) Anthranilic acid ( $Cd^{2+}$ ,  $Zn^{2+}$ ,  $Co^{2+}$ )

#### **2. Instrumental methods of analysis:**

(a) Conductometry:

- i). Titration of HCl and acetic acid with a strong base.
- ii). Precipitation titration of  $AgNO_3$
- iii). Determination of  $K_a$  for acetic acid.

(b) Colorimetry:

- i). Micro determination of chromium by diphenyl Carbazide.
- ii). Determination of iron by 1, 10 Phenanthroline.
- iii). Determination of nickel by rubeanic acid

(c) Potentiometry:

- i). Determination of  $K_1$ ,  $K_2$  and  $K_3$  for  $H_3PO_4$
- ii). Determination of Cobalt (II)
- iii). Determination of iron (II)
- iv). Determination of chloride in presence of iodide and evaluation of  $K_{sp}$  for  $AgI$  and  $AgCl$ .

(d) Thermal analysis

Decomposition studies of the following substances:



- i). Copper sulphate penta hydrate
- ii). Calcium oxalate monohydrate

- (e) Atomic absorption spectroscopy  
Estimation of following:  
 $Mg^{2+}$ ,  $Zn^{2+}$ ,  $Al^{3+}$

**3. Chromatographic Techniques:**

- (a) Column and thin layer techniques for the qualitative analysis of inorganic compounds.
- (b) Applications of solvent extraction and ion exchangers technique.

**RECOMMENDED BOOKS:**

1. J. Bassett, R. C. Denny, G. H. Jeffery and J. Mendham, Vogel's Text Book of qualitative Inorganic Analysis, the English Language Book Society and Longman, New York, (2008).
2. Quantitative Analysis Chemistry, James S. Pritz, George H. Sehenk, 2001 Alby and Becon Inc. London.
3. Theory and practice of chromatography by Prof. Dr. Javed Iqbal (2002).
4. Instrumental analysis by Gary D. Christian and James E.O., Reilly, 2007, Allyn and bacon Inc., London.
5. Hand Book of Organic reagents in Inorganic Analysis by ZAVIX Holzbecher and other 1976 Ellis Hurwod Limited, London.
6. Experimental Inorganic Chemistry - W. G. Palmer, 2005.
7. The analysis of minerals and ores of the rarer elements – W. R. Schoeller, and A. R. Powell, Charles, Griffin and Company Limited, 2004.

**M.Sc. (Part-I)****Organic Chemistry (Written) Paper - III****SYLLABUS OUTLINE:****1. Acid-base strength:**

pKa and Ka values, electronic effects (Inductive and resonance effects), field effect, solvent effect, hyper-conjugation, hydrogen bonding, steric and stereo-chemical effects, and hybridization.

**2. Stereochemistry****(a) Conformation Analysis**

The concept of conformational analysis in ethane, propane, n-butane, pentane, cyclopentane, cyclohexane, substituted alkanes, substituted cycloalkanes and decalins.

**(b) Optical isomerism:**

Configuration, Chirality and symmetry, optical isomerism upto three chiral carbon atoms, enantiomers and diastereomers, R and S nomenclature, Racemates, Racemization and Resolution of Racemates, epimerization. Walden inversion, Stereoisomerism in biphenyls, allenes and spiro-compounds

**(c) Geometrical isomerism**

Cis & Trans, and Z & E conventions, Determination of configuration, Geometrical isomerism in cyclic compounds.

**3. Active Methylene Compounds:**

Alkylation, arylation, and acylation of active methylene compounds, Acid and base catalysed aldol condensation. Conditions, mechanism and synthetic applications of the following reactions; Claisen, Claisen Schmidt, Knoevenagel, Perkin, Reformatsky, and Stobbes condensations, Darzen's glycosidic ester synthesis, Mannich and Wittig reactions.

**4. Free radical Reactions:**

Introduction, generation methods, relative stability, structure, free radical reactions and industrial applications.

**5. Oxidation and Reduction reactions:****a. Oxidation Reactions:**

Introduction, Oxidation of saturated hydrocarbons, olefinic double bonds, aromatic rings, systems containing oxygen such as alcohols, aldehydes, ketones, oxidative decarboxylation, of acids, oxidation of systems containing nitrogen such as amines, hydrazines etc..

## b. Reduction Reactions:

Introduction, Reduction of alkenes, alkynes, and aromatic rings, hydrogenolysis, reduction of benzylic and allylic systems, aldehydes and ketones, alcohols, pinacols, epoxides, acids and their derivatives, Reduction of system containing nitrogen such as imines, oximes and nitro compounds

**6. Spectroscopy:**

## a. IR Spectroscopy:

Electromagnetic radiations: IR; modes of vibration, sampling techniques, factors influencing the vibration frequencies and industrial applications

## b. UV Spectroscopy:

Ultraviolet (UV) or electronic spectroscopy: electronic transition; factors influencing the  $\lambda_{\text{max}}$  value.

**RECOMMENDED BOOKS:**

1. Organic Chemistry, Volume I (6th ed.) & II (5th ed.) by I.L. Finar, Pearson Education (singapore) Pte Ltd, 2008.
2. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th ed. by Michael B. Smith, Jerry March, Wiley, 2007.
3. Organic Chemistry, 6th Ed.; by S. H. Pine, McGraw Hill: New York, 1987.
4. Organic Chemistry 6th ed. by Francis A. Carey, McGraw Hill, 2005.
5. Organic Chemistry 6th ed. by R. T. Morrison, R. N. Boyd, and R. K. Boyd, Benjamin Cummings, 1992,.
6. Modern Synthetic Reactions 2nd ed. by H.O. House, W.A. Benjamin Inc., Menlo Park, CA
7. Principles in Organic Synthesis by R.O.C Norman & J. M. Coxon, 1993, Chapman and Hall, 1993.
8. Organic Chemistry by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press 2000.
9. Spectroscopic Methods in Organic Chemistry 6th ed. by D. Williams and I. Fleming. Wiley-VCH, 1991.
10. Spectrometric identification of Organic Compounds 6th ed. by R. M. Silverstein and F. X. Webster, Wiley, 2007.
11. Organic Spectroscopy and Chromatography by M Younas, ILMI, Pakistan, 2007.

**Organic Chemistry (Practical) Paper - VII****SYLLABUS OUTLINE:****1. Organic Preparations:**

- a. Benzyl alcohol; Ethyl benzene; benzoic acid, p-Nitrophenol, acetophenone oxime, acetophenone arylHydrazone.
- b. Synthesis of compounds containing nitro, halogeno, amino, carboxylic and carbonyl functionalities (depends upon the availability of chemicals).

**2. Quantitative and Qualitative Analysis of Organic compounds:**

- a. Estimation of glucose, and Number of acetyl groups,
- b. Physical/ Chemical separation of mixture containing two compounds, identification and derivitization.

**RECOMMENDED BOOKS:**

1. Practical Organic Chemistry by F. G. Mann and B. C. Saunders, Longman, UK, 1978
2. Vogel's Textbook of Practical Organic Chemistry (5th ed.) by A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, 1989, Longman UK, 1989.
3. The Systematic Identification of Organic Compounds, (8th ed.) by Ralph L. Shriner et al., Wiley, 2003.
4. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC, 1994.
5. Advanced Practical Organic Chemistry (2nd ed.) by N. K. Vishnoi, Vikas Publishing House Pvt Ltd , India, 1996.

**M.Sc. (Part-II)****Organic Chemistry (Special Written) Paper I-C****SYLLABUS OUTLINE:****1. Aromatic Substitution reactions:****(a) Electrophilic substitution:**

General mechanism (kinetic, isotopic and spectroscopic evidences), nitration, sulfonation, halogenation, Friedel-Crafts alkylation and formylation, structure and reactivity, orientation; polysubstitution reations of aromatic compounds

**(b) Nucleophilic Substitution reactions:**

$S_N1$ ,  $S_N2$  (addition and elimination), and Benzyne mechanism

**2. Molecular Rearrangements:**

Classification of molecular rearrangements: mechanism of intramolecular 1,2-shifts involving migration of a group from carbon to carbon, carbon to nitrogen, and carbon to oxygen, mechanism and synthetic applications of Wagner-Meerwein, Pinacol-pinacolone, benzidine, benzyl, benzylic acid, Favorski, Wolff, Beckmann, Hoffmann, Curtius, Lossen and Schmidt; Baeyer-Villiger, Dakin and Fries rearrangements.

**3. Heterocyclic Chemistry:**

Five and six membered hetrocycles with one and several identical hetro-atoms, Five and six membered hetrocycles with two different hetro-atoms

**4. Reactive Intermediates:**

Carbenes, nitrenes, and Arynes, structure and evidence for formation, general reactions and synthetic applications

**5. Organic Synthesis:**

An outline of the recent developments in organic syntheses involving boron, phosphorus, silicon reagents, reaction conditions and methods; phase transfer catalysis involving quaternary ammonium, phosphonium salts and crown ethers, solid phase synthesis, Introduction to protective groups, protection of hydroxyl, amino, carbonyl and carboxylic groups, reactions involving the introduction and removal of some common protective groups and synthetic applications. Introduction to disconnection approach.

**6. Pericyclic reactions:**

Introduction, Woodward-Hoffmann rules and molecular orbital theory; cycloaddition, electrocyclic and sigmatropic rearrangement and group transfer reactions.

**RECOMMENDED BOOKS:**

1. Organic Chemistry, Volume I (6th ed.) & II (5th ed.) by I.L. Finar, Pearson Education (Singapore) Pte Ltd, 2008.
2. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th ed. by Michael B. Smith, Jerry March, Wiley, 2007.
3. Organic Chemistry, 5th ed.; by S. H. Pine, McGraw Hill: New York, 1987.
4. Organic Chemistry 6th ed. by Francis A. Carey, McGraw Hill, 2005.
5. Organic Chemistry 6th ed, by R. T. Morrison, R. N. Boyd, and R. K. Boyd, Benjamin Cummings, 1992,.
6. Phase-transfer catalysis: fundamentals, applications, and industrial perspectives by C. M. Starks, C.L. Liotta and M. Halpern, Chapman & Hall, 1994.
7. Principles in Organic Synthesis by R.O.C Norman & J. M. Coxon, Chapman and Hall, 1993.
8. Organic Chemistry by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press 2000.
9. Heterocyclic Chemistry, 4th ed. by J. A. Joule, K. Mills, Blackwell Publishing, 2000.
10. Heterocyclic Chemistry, 3rd ed. by T.L. Gilchrist, Longman, 1997.
11. Electrocyclic Reactions by F. L. Ansari, R. Qureshi, M. L. Qureshi, 1999, Wiley-VCH.
12. Reactive Intermediates in Organic chemistry, N. S. Isaac, John Wiley and Sons, 1974.
13. Work book for Organic Synthesis, The disconnection approach, Stuart Warren, John Wiley and Sons, 1994.
14. Organic Synthesis, The disconnection approach, Stuart Warren, 1993, John Wiley and Sons 1993.
15. Designing Organic Synthesis, A Programmed Introduction to synthon approach, S. Warren, John Wiley and Son, 1992.
16. Guide book to Organic Syntheses, R. K. Mackie, D. M. Smith, Longman Group Limited, 1982.

## Organic Chemistry (Additional Written) Paper II-C

### SYLLABUS OUTLINE:

#### 1. Determination of Reaction Mechanism:

Determination of reaction mechanism, kinetics, stereochemical, intermediate formation, spectroscopic and isotopic labeling methods

#### 2. Aliphatic Nucleophilic substitution:

Mechanism of SN1, SN2, SNi, SN1', SN2' and SNi' reactions, kinetics, stereochemical and other evidence; effects of other substrate structure, attacking nucleophile, leaving group and solvent effect, and neighbouring group participation.

#### 3. Elimination Reactions:

Mechanism of E1, E2, and E1cb elimination reactions; kinetics and stereochemical studies; applications of thermodynamically and kinetically controlled reactions (Saytzeff and Hoffmann reactions), Effects of substrates, solvent, base, leaving group and temperature on kinetics, competition between elimination and substitution reactions; pyrolytic elimination reaction mechanism and synthetic applications.

#### 4. Nuclear Magnetic Resonance Spectroscopy:

Nuclear magnetic resonance: Basic principles, theory, spin flipping, nuclear precession and absorption of electromagnetic radiation, spin relaxation, basic introduction of 1-D (<sup>1</sup>H and <sup>13</sup>C) NMR spectroscopy, chemical shifts and integration curve, instrumentation, spin-spin splitting and coupling constants. Structure elucidation of small molecules. Introduction of 2-D NMR spectroscopy.

#### 5. Mass Spectroscopy:

Introduction; types, Isotopic abundance, molecular and metastable ions; fragmentation pattern, applications of mass spectroscopy in different classes of organic chemistry, interpretation of mass spectra of small organic molecules.

#### 6. Natural Products:

Introduction, classification, isolation, biosynthesis and general methods for the structure determination of alkaloids (piperine, Nicotene, Cocaine, Morphine, Quinine), steroids (cholesterol, progesterone, estrogens, androgens, glucocorticoids mineralocorticoids) and terpenoids (Triterpenes, α-amyrin, β-amyrin, Ursolic acid, Oleanolic acid).

### RECOMMENDED BOOKS:

1. Organic Chemistry, Volume I & II by I.L. Finar; fifth bedi. Longman scientific technical, 1975.
2. Spectroscopic Methods in Organic Chemistry by D.Williams and I. Fleming.
3. Spectrometric identification of Organic Compounds by R. M. Silverstein; sixth edition, Wiley, 2007.
4. Organic Spectroscopy and Chromatography by M Younas, ILMI, Pakistan

5. Spectroscopy by Pavia, Lampman, Kriz, second Edition, Harcourt Brace College Publishers, 1996.
6. Biosynthesis of Natural Products, Paolo Manito, John Wiley & Sons, 1980.

**Organic Chemistry (Practical) Paper III-C****SYLLABUS OUTLINE:****1. Qualitative analysis:**

Three component organic mixture analysis (separation and identification of the unknown components)

**2. Chromatography and Spectroscopy:**

Separation of mixtures by chromatography and identification by spectroscopy

**3. Organic Synthesis:**

- (a) Multi-step preparation and spectroscopic characterization: *p*-nitroaniline from aniline; *p*-bromotoluene from *p*-toluidine, *o*-Bromotoluene from *o*-toluidine
- (b) Preparation, separation and identification of regio-isomers: *o*-nitrotoluene and *p*-nitrotoluene from toluene; *o*-nitrosophenol and *p*-nitrosophenol from phenol

**RECOMMENDED BOOKS:**

1. Practical Organic Chemistry by F. G. Mann and B. C. Saunders, 1978, Longman, UK, 1978
2. Vogel's Textbook of Practical Organic Chemistry (5th ed.) by A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, Longman UK, 1989.
3. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
4. Advanced Practical Organic Chemistry (2<sup>nd</sup> ed.) by N. K. Vishnoi, Vikas Publishing House Pvt Ltd. India, 1996.



**M.Sc. (Part-I)****Analytical Chemistry (Written) Paper – IV(ii)****SYLLABUS OUTLINE:****1. Introduction / Assessment of Analytical Data**

Introduction and scope of Analytical Chemistry: Analytical problems and their solutions; The nature of analytical methods; trends in analytical methods; Different units of concentration and their conversion; Definition and basic concepts: nature and origin of errors, Classification of errors; Accuracy and Precision; Limits of detection, Confidence limits; Deviation, Standard deviation, Application of statistical tests; Rounding off analytical data; Quality control charts; Computation of analytical data. Significance of sampling, weighing and measuring in Analytical chemistry.

**2. Basic Chromatography Techniques**

Classifications of Chromatographic Techniques, Paper and Thin Layer Chromatographic Techniques; their instrumentation, applications and limitations, Column Adsorption Chromatography.

**3. Introduction to Spectroscopy / Spectrophotometry**

Introduction to Molecular spectroscopy, absorption in UV and Visible range; Basic principle of Spectrophotometry; Beer-Lambert's law; Deviations; Instrumentation and application.

**4. Ion Exchange Chromatography:**

Cation Exchange resin, Anion Exchange resin, Cross-linkage, Effect of pH-separation of Amino Acids, Separation of metal ions on Anions Exchange Columns, Applications of ion Exchange Chromatography.

**5. Solvent Extraction:**

Basic principle of solvent extraction, The Distribution Coefficient, The Distribution Ratio, The Percent Extracted Solvent Extraction of Metals, Analytical Separations, Multiple Batch Extractions, Countercurrent Distribution, Solid-Phase Extraction, Solvent Extraction by Flow Injection Analysis.

**6. Electrophoresis:**

Capillary Zone Electrophoresis, Application of traditional Electrophoresis Gel Chromatography.

**7. Flame Emission:**

Basic principle of atomic spectroscopy; Use of atomic spectra for detection and determination of elements; flame as a source of atomization and excitation; Instrumentation involved in FES; applications and limitations.

**8. Atomic Absorption Spectroscopy:**

Basic Principle of AAS; Flameless AA spectroscopy including graphite furnace and hydride generation.

**RECOMMENDED BOOKS:**

1. Analytical Chemistry by J.D. Dick, McGraw Hill, 1973, N.Y. also available in International students edition McGraw Hill, Mogakusha, 1973.
2. Instrumental Methods by W.Ewing, Mc Graw Hill Book Co. N.Y. (Third/Fourth Edition) also available in International students edition.
3. Chromatography by R.K Sharma , Gogel publishing home meerret
4. Introduction to chromatography by Nasir-ud-din, Published by author
5. Paper chromatography by Dr.Friedrich Cramer, London Macmillan and Co Ltd
6. Thin- layer chromatography by Marini, Elsevier publisher
7. Modern analytical chemistry by David Harvey, Roohani-art press, Islamabad
8. Principle and Practice of analytical chemistry by Fillfield, Blackwell Science Ltd
9. Spectroscopy by Browing, Mcgram Hill London
10. Fundamentals of Chromatography by H.G. Cassidy, Inter Science Publisher, London, N.Y.
11. Fundamentals of Analytical Chemistry by Douglas Skoog and Donald M. W. West, Holt Reinchart and Inc, London.

**Analytical Chemistry (Practical) Paper – VIII(ii)****SYLLABUS OUTLINE:****1. Calibration**

Calibration of glassware (pipette, burette and flask) used for volumetric analysis. Use of analytical balance and calculation of standard deviation. Calibration of pH meter and determination of pH of various acidic and basic solution.

Calibration of conductometer and determination of conductance of tap water, distilled water, conductivity water and canal water.

Calculation of dissociation constants of various acids.

Calculation of variance, mean, median, coefficient of variance of the data.

**2. Basic Chromatography**

Separation of ink components by paper chromatography.

Separation of amino acids by thin layer chromatography.

Separation of dyes by column chromatography.

Separation of mixtures by circular paper chromatography.

**3. Flame Emission / Spectrophotometry:**

Determination of Sodium in tap water by using Flame Photometer.

Determination of Potassium in tap water by using Flame Photometer.

Find out the calcium in chalk sample by flame photometry.

Determination of Ba by flame photometry.

Estimation of purity of various compounds on the base of flame emission Spectrophotometry.

Indirect determination of various compounds by flame photometric techniques.

Determination of  $\lambda_{max}$  of  $KMnO_4$  and  $K_2Cr_2O_7$  by using spectrophotometer.

Verification of Beer and Lambert Law.

Ultraviolet spectrophotometric determination of Aspirin, Phenacetin and Caffeine in APC tablet using Solvent Extraction.

**RECOMMENDED BOOKS:**

1. Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman.
2. Introduction to chromatography by Nasir-ud-din, Published by author.
3. Paper chromatography by Dr. Friedrich Cramer, London Macmillan and Co Ltd.
4. Thin-layer chromatography by Marini, Elsevier publisher.

**M.Sc. (Part-II)****Analytical Chemistry (Special Written) Paper I-E****SYLLABUS OUTLINE:****1. Gas Liquid Chromatography / Gas Solid Chromatography:**

Gas Chromatographs, Derivative Formation, Gas Chromatographic Columns, Liquid Phases and Column Selection, Detectors for Gas Chromatography, Optimization of Experimental Condition, Gas-Solid Chromatography, Interfacing Gas Chromatography with Mass Spectrometry, Interfacing Gas Chromatography with Infrared Spectrometry,

**2. High Performance Liquid Chromatography:**

Optimization of Column Performance, Gradient Elution and Related Procedures, Derivation, HPLC Instrumentation, Mobile-Phase Delivery System, Sample Introduction, Separation Columns, Detectors, Interfacing HPLC with Mass Spectrometry

**3. Potentiometry:**

Nernst equation; Electrode Potentials; different reference electrodes including glass and calomel electrode; working of a potentiometer and its applications including pH measurements and potentiometric titrations; ion-selective electrode systems; ion-exchange membrane electrode; gas-sensing electrode; solid-state membrane electrode and bio membrane electrode.

**4. Thermo gravimetric Analysis / Differential Thermal Analysis:**

General Principle of thermal, instrumentation, types of measurements; TGA (thermogravimetric analysis), DTA (differential thermal analysis), DSC (differential scanning calorimetry), TT (thermometric titrations) and EGD (evolved gas detection), Principles, instrumentation and applications of these techniques.

**5. Voltametry:**

Principle and applications of anodic stripping voltametry

**6. Polarography:**

Introduction and principle of polarography, basic instrumentation, working and advantages of DME (dropping mercury electrode); limiting and residual current; half-wave potential; qualitative and quantitative aspects of polarographical analysis

**7. Amperometry:****8. Conductometry:**

Conductance in Solutions; Specific conductance; molar conductance; factors upon which the conductance of solution depends; Measurement of conductance; cell constant; Analytical applications of conductance measurement.

**9. Arc / Spark / Glow, Automation:**

**RECOMMENDED BOOKS:**

1. Vogel's, s text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman.
2. Vogel's, text book of Quantitative chemical analysis by J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, Pearson Education Ltd.
3. Advances in electrophoresis by Andrea Chrmambach , Wiley- VCH.
4. Chromatographic Methods of Analysis by Stock & Rice, Elsevier Co. Amsterdam.
5. Electro Analytical Chemistry by J.J. Longane, Inter Science Publisher Inc. N.Y. London.
6. Analytical Chemistry by Gary D. Christian, John Wiley and Sons (1977).
7. Principles of Polarography by J. Herosky & J. Kuta, Academic Press N.Y. (1968).

**Analytical Chemistry (Additional Written) Paper II-E**

**SYLLABUS OUTLINE:**

**1. FTIR / Raman Spectroscopy:**

Origin of Infra Red Spectra; Different vibrational modes, Normal coordinate and normal vibrations, Symmetry of normal vibrations and selection rule, Raman Spectroscopy, Metal-isotope spectroscopy, Vibrational Spectra in gaseous phase and inert gas matrices; Comparison of raman with Infra Red spectroscopy; Applications for qualitative and quantitative chemical analysis; Instrumentation details and their function.

**2. UV / Vis Spectroscopy:**

The Nature of Electromagnetic Radiation, The Electromagnetic Spectrum, Atomic Energy Levels, molecular Electronic Energy Levels, Vibrational Energy Levels, Raman Effect, Lasers, Radiation Sources, Wavelength Selection, Cells and Sampling Devices, Detectors, Readout Modules, Instruments for Absorption Photometry

**3. Atomic / Mole Fluorescence:**

Atomic Fluorescence Spectroscopy; Instrumentation, applications and limitations of these techniques

Plasma Source

Inductively coupled plasma sources, special detection systems and read out devices used for ICPEES; multielement analysis with plasma devices.

**4. Laser Spectroscopy:**

Principle of laser operation; Stimulated emission Population inversion, Single level and multi-level laser systems, Properties of laser light and its general and analytical applications; ruby laser, nitrogen laser, dye laser, Use of laser radiation in absorption and fluorescence spectroscopic methods.

**5. Nuclear Magnetic Resonance Spectroscopy:**

Basic principles; properties of nuclei, Chemical shifts; Spin-Spin coupling; Pulsed Fourier Transform NMR Spectrometry; Identification of structural features; Use of NMR imaging in medicine; Analytical applications of NMR spectroscopy.

**6. Mass Spectrometry:**

Principle of mass spectrometry; Intel system, ionization, acceleration, Drift Chamber, Detection systems; Advancements in equipment in equipment; Analytical uses of mass spectrometry, Quadrupole mass spectrometry; Interpretation of mass spectra. Correlation of mass spectra with Molecular structure.

**RECOMMENDED BOOKS:**

1. Mass Spectrometry textbook by Jurgen H Gross, Springer-Verlag Berlin Heidelberg.
2. Nuclear Magnetic Resonance Spectroscopy by G.A Webb, RSC publishing.
3. Chemical Application of Spectroscopy by West, Inter Science Publisher Inc. N.Y. London.
4. Kinetics in Analytical Chemistry by H.B. Mark Jr. & G.A. Rechnitz, Interscience N.Y. (1968).
5. Analytical Chemistry by Gary D. Christian, John Wiley and Sons (1977).
6. Automated Chemical Analysis by J.K. Forman Stockwell, John Wiley and Sons, N.Y. (1975).
7. Advances in Infrared Group Frequencies by L.J. Bellacy, Mathuen & Col. Amsterdam (1968).
8. Laser spectroscopy by Wolfgang Demtroder, springerlink.

**Analytical Chemistry (Practical) Paper III-E****SYLLABUS OUTLINE:****1. Molecular Spectrophotometry:**

Determination of Iron (II) using 1, 10-phenanthroline method.

Determination of Iron (III) using thiocyanate method.

Determination of chromium by diphenylcarbazide method.

Determination of Fe, Pb, Cd, Zn and Cu in soil samples by AAS technique.

Simple acid base titrations using potentiometer.

Determination of "F" in water by using ion selective electrodes.

Preparation of standard calibration graphs of Pb, Cd, Zn and Fe by AAS.

Determination of Ni by DMG method spectrophotometrically.

Determination of mixtures of complexes of Iron with Thiocyanide and 1, 10, phenanthroline.

Determination of  $\lambda_{max}$  of Cr complex with diphenyl carbazide.

Infrared Determination of a Mixture of Xylene

Spectrophotometric determination of Lead or Leaves using Solvent Extraction.

**2. Conductometry:**

Determine the amount of HCl conductometrically by using strong base NaOH.

Determine the amount of base  $NH_4OH$  conductometrically by using strong acid.

Determine the amount of  $\text{NH}_4\text{OH}$  by using weak acid  $\text{CH}_3\text{COOH}$  conductometrically.

Determine the amount of  $\text{NaOH}$  conductometrically by using weak acid  $\text{CH}_3\text{COOH}$ .

**3. Potentiometry:**

Determine the amount of  $\text{HCl}$  by using strong base ( $\text{NaOH}$ ) potentiometrically.

Determine the amount of  $\text{HCl}$  by using weak base ( $\text{NH}_4\text{OH}$ ) potentiometrically.

Determine the amount of  $\text{CH}_3\text{COOH}$  by using strong base (naoh).

Determine the amount of  $\text{HCl}$  &  $\text{CH}_3\text{COOH}$  conductometrically by using strong base  $\text{NaOH}$ .

**RECOMMENDED BOOKS:**

1. Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman.
2. Atomic and molecular spectroscopy. Basic concepts and practical application by Sune Svanberg, springerlink Berlin Heidelberg.

**M.Sc. (Part-I)****Applied Chemistry (Written) Paper – IV(iii)****SYLLABUS OUTLINE:****1. Chemical Industrial Unit Operations and Processes:**

Brief introduction to Chemical Industry with reference to Pakistan, Elementary treatment of general unit operations commonly used in Industry such as heat transfer; Evaporation; size Reduction; Screening; Filtration and Distillation. Chemical; Unit processes, Nitration; Sulphonation; Halogenation; Hydration; Oxidation and Hydrogenation.

**2. Basic Chemical Industries**

Raw materials; Chemical processes involved; flow sheet diagrams with all the important parameters concerned with the manufacturing of Sulphuric acid; Hydrochloric acid; caustic Soda; Washing soda; Oxalic Acid, Formic acid, Pthalic anhydride. Applications of these chemicals in industry.

**3. Cement Industries:**

Cement raw materials used for cement manufacturing, dry process, wet process, semi wet process, special cement, chemistry involved in hydration of cement, setting of cement, setting time.

**4. Water Softening and Scale Removing:**

Water hardness; its measurement and removal; methods used for water softening including ion-exchange and reverse osmosis, distillation and precipitation. Types of boiler scales. Chemical and mechanical methods to eliminate the scaling.

**5. Glass Industries:**

History of glass, raw materials used for glass, methods of manufacturing, various types of furnaces and crucibles used for the manufacture of glass, special types of glass, their manufacture and properties.

**6. Soap and Detergent Industries:**

Processes involved in soap manufacturing, methods used for manufacture of laundry soap, typical soaps. Recovery of glycerine. Detergents or surface active agents, cationic, anionic and non-ionic agents.

**RECOMMENDED BOOKS:**

1. Industrial Organic Chemicals, by H.A.Witcoff and B.J.Reuben, John Wiley & Sons Inc. New York.
2. Water Supply and Sewerage, T.J.McGhee, McGraw Hill Book Co. New York.(1991)
3. Unit operations in Chemical Engineering, Chattopadhyay, Khanna Publishers, Delhi-6 (1993).
4. Chemical Process Design, Robin Smith, McGraw Hill Book Co. New York. (1995).



5. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers, Small Industries Research Institute, New Delhi (1995)
6. Small Medium and large Scale Industries, A.K. Sirivastawa, Small Industries Research Institute, New Delhi (1996).
7. The Chemistry of Cement, H.F.W. Taylor, Academic Press, London, 1964.
8. Shereve's Chemical Process Industries, 5th Ed.1975, By G.T.Austin, McGraw Hill Book Co. New York.
9. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
10. Chemistry of glass manufacturing, F.W.Hunter, Dower Publications, New York, 1950.

### Applied Chemistry (Practical) Paper – VIII (iii)

#### SYLLABUS OUTLINE:

##### 1. Preparations:

Detergent and cosmetics (Cold cream, shampoo and vanishing cream), Dentrifrice, Thermosetting and thermoplastic resins (alkyd and urea formaldehyde)

##### 2. Titrimetry:

Estimation of water hardness by complexometry  
Estimation of acetic acid contents in the vinegar sample  
Determine the acidity of the sulphuric acid and its normality.  
Determination of acidity, alkalinity, Free CO<sub>2</sub> in water  
Assay of bleaching powder by free chlorine method.  
Determine the %age purity of the Commercial sample of sodium chloride.  
Determination of Residual Chlorine in water.  
%age of reducing sugars.  
Soap anlysis for free and combined alkali.  
Determining the %age purity of sodium bicarbonate and sodium carbonte.

##### 3. Flamephotometry:

Estimation of Potassium in the tap water.  
Estimation of Sodium in the Commercial Sodium Chloride.  
Estimation of Calcium in milk.

##### 4. Spectorphotometry:

Determination of the of KMnO<sub>4</sub>, K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> and CoCl<sub>4</sub>  
Estimation of nickel in vanaspati ghee.  
Estimation of chloride in the tannery effluent.  
Estimation of Iron in Pharmaceutical Products.  
Estimation of Phosphates in fertilizers.

##### 5. Chromatography:

Separation of mixture of ink by circular paper chromatography.  
Separation of mixture of metal ions by paper chromatography.  
Coating of TLC plates and separation of mixture of dyes.  
Separation of different pigments of plant extract by TLC chromatography.

**RECOMMENDED BOOKS:**

1. Perfumes Cosmetics and Soaps, W.A. Poucher, Chapman and Hall 7th Ed. (1974).
2. Applied Chemistry Theory and Practice, O.P. Vermani & A.K. Narula, Wiley Eastern Limited (1989).
3. Text Book of Quantitative Inorganic Analysis, Vogel's Ed-4<sup>th</sup>, Longman Group Limited (1978).
4. Practical Statistics for the Analytical Scientist, A Bench Guide, RSC Publishing LGC Ltd 2009.

**M.Sc. (Part-II)****Applied Chemistry (Special Written) Paper I-F****SYLLABUS OUTLINE:****1. Processing of Crude Oil:**

Brief description of origin of petroleum, Migration, reservoir, exploration and drilling of crude petroleum; Various unit processes involved petroleum processing like surface operation, fractional distillation; refining, cracking; reforming, isomerization; Polymerization, alkylation and finishing processes.

**2. (a) Oils and Fats:**

Classification of oils and fats, vegetable oils, essential oils, various methods of extraction of oils, refining and hydrogenation of oils, Industrial applications of oils in resins, surfactants, lubricants and paints.

**(b) Petrochemicals:**

Chemistry and importance of the following petrochemicals: Acetylene; ethylene; propylene, benzene, toluene, xylene and naphthalene. Oxidation halogenation and nitration of petrochemicals of industrial significance.

**3. Leather Tanning Industries:**

Introduction, important steps in leather manufacturing, theory of leather tanning, waste disposal and pollution aspects involved in tanning industries.

**4. Fertilizer Industries (Ammonia, Urea and other Fertilizers):****(a) Ammonia:**

Raw materials, various sources of hydrogen and nitrogen, manufacture of ammonia (Haber's process), its use as fertilizer and other applications.

**(b) Urea:**

Raw materials, manufacture of urea, assimilation in soil.

**(c) Calcium Fertilizers:**

Calcium ammonium nitrate, calcium cyanamide, calcium super phosphate and triple super phosphate.

**(d) Potash Fertilizers:**

Manufacture and use of potash fertilizers.

**5. Paper and Pulp Industries:**

History and back ground, survey of raw materials, production of pulp by soda process, sulphite process and Kraft (sulphate) process, Manufacture of paper environmental aspects of paper industry.

**6. Polymers:**

General classification of polymers, characteristics and significance of polymers, various mechanisms of polymerization process, Polymer processing like extrusion, injection, modeling and blow molding of plastics.

Brief description and uses of the following polymers:

Polyethylene, polystyrene, epoxy resins, polyethylene tetraphthalate.

**RECOMMENDED BOOKS:**

1. Pulp and Paper Technology, Testing and Applications, K.P. Rao (2003), CBS Publishers.
2. Chemistry of Pulp and Paper making, Edwin Sutermeister, Ed-3<sup>rd</sup> (1946).
3. Fertilizers and Soil Fertility, U.S.Jones, Reston Publishing Co. Virginia, 1979.
4. Petroleum Refining Technology, Ram Parsad (2002).
5. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
6. Shereve's Chemical Process Industries, 5th Ed. 1975, By G.T. Austin, McGraw Hill Book Co. New York.
7. Food Oils and Fats, H. Lawson, CBS Publishers and Distributors, New Delhi. (1997).
8. Leather in life art and industry, John W. Waterer, 1927. Faber and Faber Ltd.
9. A Text on Petrochemicals, Bhaskararsao, 2002.
10. An Introduction to Polymer Chemistry, W.R. Moor, London Press, London.
11. Principles of Polymer Systems, Rodri-Guez, McGraw Hill Book Co. New York.
12. Modern Technology of Plastics and Polymer Processing Industries, NIIR Board
13. Petroleum Refining Technology, Ram Parsad (2002).

**Applied Chemistry (Additional Written) Paper II-F****SYLLABUS OUTLINE:****1. Steel, Metallurgical Products and Electroplating:****(a) Steel and Metallurgical Products:**

Manufacture of cast iron and steel, wrought iron, formation of alloys, heat treatment of steel, classification of steel, passivity, different theories of rusting of iron and its prevention.

**(b) Electroplating:**

Principle of electroplating, purpose of electroplating, different processes involved in electroplating, chrome plating, nickel plating and electroplating of plastics.

**2. Sugar Industry and Related Chemicals:**

Extraction of juice from sugar cane, purification of juice, clarification, concentration, refining and crystallization. Beet sugar. Glucose and hydrogenated glucose syrups.

**3. Analytical Techniques and on-line analysis in Industry:****(a) Spectroscopy:**

Use of different spectroscopic techniques like FES, AAS and Spectrophotometry for the quality control of raw materials, intermediates and final products in various industries.

**(b) Chromatography:**

Use of Thin layer chromatography, gas chromatography and HPLC in pharmaceutical and other industries.

**(c) On-Line Analysis and Automation:**

Significance of on-line analysis and automation of analytical techniques in industry; Classification of techniques w.r.t. automation, Use of microprocessor in conjugation with automation and on-line analysis, different types of automatic analyzers.

**4. Coal Chemicals fuel Gases:**

The destructive distillation of coal, coking of coal distillation of coal tar; Liquid Fuels: Hydrogenolysis Natural gas; Coal Gas: Water Gas; Liquefied Petroleum Gases.

**5. Textile Dyeing:**

Color and chemical constitution, Important classes of chromogens, Classification and nomenclature of dyes, manufacturing of dye intermediates and dyes, Selection of dyes for wool, cellulosic and synthetic fibers, Theory of Coloration, Coloration of wool, cellulosic and synthetic fibers.

**6. Textile Fibers:**

Classification of synthetic fibers, chemistry and manufacturing of viscose rayon, true synthetic fibers including nylons and polyester fibers. Finishing processes for 100% cotton fabrics such as singeing, desizing, scouring, mercerizing and bleaching.

**RECOMMENDED BOOKS:**

1. Chemistry of iron and Steel Manufacture, C.Bodsworth, Longman Press, London, 1963.
2. Instrumental method of Analysis, Willar Merritt Dean Settle, Seventh Edition (1986).
3. Graham's Electroplating Engineering Hand Book, Ed. L.J. Durney, CBS Publishers and Distributors, New Delhi.(1997).
4. Nickel and Chromium plating, J.K.Dennis & T.E.Such, Newness Butterworth, London (1972).
5. T. B. of Quantitative Inorganic Analysis, Vogel's Ed-4<sup>th</sup>, Longman Group Limited (1978).
6. Instrumental Analysis, Gary D. Christain, 1978, Introduction to Instrumental Analysis by Braun, McGraw-Hill Book company, 1987.
7. Dyes and Dyeing, C.E. Pellow, Abhishek Publishers, 1998.
8. Textile Dyes and Pigments, H. Panda, NIIR Publishers.
9. The Chemistry of Synthetic Dyes and Pigments, H. A. Lubs, Reinhold Publishing Corporation, 1955.

10. Fibre to fabric, 4<sup>th</sup> Ed, Potter & Corban, McGraw Hill book Company, 1959.
11. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
12. Shereve's Chemical Process Industries, 5th Ed.1975, G.T.Austin, McGraw Hill Book Co. New York.
13. Sugar: Science and Technology, G. G. Birch and K.. J. Parker, Applied Science Publishers Ltd., 1979.
14. Principles of Sugar Technology, Pieter Honig Vol I, Elsevier Publishing Company, 1953.

## Applied Chemistry (Practical) Paper III-F

### SYLLABUS OUTLINE:

#### 1. Oil & Fats

Acid value; Ester Value; Saponification value and Iodine value of different vegetable oils

#### 2. Water Pollution

- (a) Dissolved Oxygen
- (b) Biological Oxygen Demand
- (c) Chemical Oxygen Demand
- (d) Heavy metals in industrial effluents by AAS.

#### 3. Industrial Analysis

Steel Analysis involving volumetry, spectrophotometry and solvent extraction.

Analysis of dolomite; haemetite; chromite and bauxite ores involving separation and analytical techniques.

Sucrose in sugar cane juice using polarimetry.

Analysis of effluents from leather tanneries.

Assay of pharmaceutical products like aspirin, paracetamol, and chloramphenicol using spectroscopic techniques.

#### 4. Textile

Dyeing of clothes in different shades using Acid dyes

#### 5. Petroleum:

Determination of diesel index, Aniline point and Pour point of lubricating oil.

#### 6. Spectrometry:

Simultaneous determination of chromium and manganese in steel.

Determination of pK value of indicators (methyl orange and methyl red).

#### 7. Polymer:

Depolymerization of polyethylene terephthalate.

Catalytic degradation of polythene.

**RECOMMENDED BOOKS:**

1. Metallurgical Analysis, Lord (1893).
2. Applied Chemistry Theory and Practice, O.P. Vermani & A.K. Narula, Wiley Eastern Limited (1989).
3. T. B. of Quantitative Inorganic Analysis, Vogel's Ed-4<sup>th</sup>, Longman Group Limited (1978).
4. Practical Statistics for the Analytical Scientist, A Bench Guide, RSC Publishing, LGC Ltd 2009.
5. Dyes and Dyeing, C. E. Pellew, Abhishek Publishers (1998).
6. Experiments in Physical Chemistry, David P. Shoe Maker, McGraw Hill International (1996).

**M.Sc. (Part-I)****Biochemistry (Written) Paper – IV(i)****SYLLABUS OUTLINE:****1. Introductory Biochemistry:**

Scope of Biochemistry. The molecular logic of life. Structure and Functions of Cells. Cell wall Composition. A brief description on the isolation of cellular components.

**2. Water:**

Weak interactions in aqueous system. Ionization of water. Weak acids and weak bases. pH and buffer systems. Different buffering agents. Importance of buffers in biological systems.

**3. Carbohydrates:**

Nature, Structure and Classification of Carbohydrates. Aldoses and Ketoses Cyclic structure of monosaccharides, Haworth configurations D and L configuration of monosaccharides, Optical isomerism and Mutarotation in glucose. Formation of Glycosidic bonds. Reducing and non reducing sugars. Important monosaccharide and their derivatives. Invert sugars. Biological significance of Glucose. Structures and functions of common Disaccharides and Polysaccharides: Sucrose, Lactose, Maltose Amylose and Amylopectins. , Cellulose, Chitin Glycogen, Starch and Dextran. Derived carbohydrates and hexose derivatives present in microorganisms. Sensory properties of monosaccharides. Proteoglycan and glycoproteins: their Structure and function.

**4. Nucleic acids:**

Purines, Pyrimidines and nucleotides. Structure and functions of DNA, different type of RNA. Nucleic acid hydrolysis. Determination of Primary structure of Nucleic acids. Chemical synthesis of oligonucleotides.

**5. LIPIDS:**

Lipid Classification, Structures and functions. Chemical Properties of triglycerides. Phospholipids. Sterol/steroids. Lipid with specific biological activities. Prostaglandins: Structure and function. Properties of lipid aggregates: Micelles and Bilayers. Biological membranes. Membrane proteins, Membrane structure and Assembly. Fluid Mosaic model. The erythrocyte membrane. .

**6. PROTEINS:**

Amino acids: their Structure, Chiral Center, and stereoisomerism. Classification of amino acids. Acid base properties, their titration curve and its importance. . Amino acid sequence. Peptides and their biological importance. Proteins: classification, Covalent structure and biological significance including Primary. Secondary, Tertiary and Quaternary structure of proteins, as Keratins, Collagens and elastin. Conformation and function of globular proteins with special reference to structure and function of Hemoglobin and Myoglobin. Biological significance of Proteins.



**7. ENZYMES:**

Chemical nature, nomenclature and classification of enzymes. Cofactors and Coenzymes. Concepts of Active site. Substrate specificity. Affect of different factors on enzyme activity. Kinetics of single substrate reactions. Quantitative assay of enzymatic activity. Enzyme inhibition: Competitive, non-competitive and irreversible inhibition. Regulatory enzymes, allosteric enzymes, Multienzyme system, Zymogons, isoenzyme. Immobilized enzymes.

**8. NUTRITION:**

Introduction to the science of nutrition: Nutrients and their functions Biological evaluation of proteins, carbohydrates and lipids. Sources and forms of Energy. Energy value of foods. Energy requirements under different living and physiological conditions. Direct and indirect Calorimetry. Basal metabolic Rate, Respiratory quotient and their measurements. Assessment of nutritional status in Pakistan. Thermogenic effects of food.

**RECOMMENDED BOOKS:**

1. Principles of Biochemistry by Lehninger AL, Nelson DL and Cox MN, 2000 Pub: worth Publishers
2. Biochemistry by Lubert Stryer 2006 Pub: Freeman and Company
3. Biochemistry by Voet, and Pratt, 2004, John wiley and sons Inc.
4. Lippincott's Biochemistry by Champe.P C; Harvey. R. A and Ferrier. D. R. 3rd ed., 2004 Pub: J. b. Lippincott Company
5. Harpers Biochemistry, 27th ed. 2006 Pub: McGraw Hill Inc.

**Biochemistry (Practical) Paper – VIII (i)**

**SYLLABUS OUTLINE:**

**1. Carbohydrates:**

Qualitative tests for Carbohydrates. Distinction between pentoses and hexoses, aldoses and Ketoses, reducing and non reducing sugars mono and polysaccharides. Chromatography of sugars. Preparation of glycogen from liver. Acid and enzymic hydrolysis of glycogen.

**2. Nucleic Acids:**

Isolation of RNA from beef liver. Isolation of DNA from Calf Spleen. UV absorption of nucleic acids.

**3. Lipids:**

Qualitative tests for lipids including fatty acids, sterols and phospholipids. Lipids separation from Calf brain tissue. Acid value, Saponification Value and Iodine Value of fats. Extraction and TLC of Wheat Lipids.

**4. Amino Acids and Proteins:**

Qualitative tests of amino acids, determination of isoelectric Point. Isolation and solubilization of proteins from plant and animal origin. Hydrolysis of proteins. Estimation of proteins by Kjeldahl method. Isolation of enzyme amylase, a study on its properties and catalytic activity.

**RECOMMENDED BOOKS:**

- 1 Practical Clinical Biochemistry by Varley. Pub: CBS publishersAn
- 2 Introduction to Practical Biochemistry By D. T. Plummer Pub: McGraw Hill

**M.Sc. (Part-II)****Biochemistry (Special Written) Paper I-D****SYLLABUS OUTLINE:****1. Basis of Metabolism:**

Methods of metabolism study. Cell bioenergetics and Role of ATP. Biological oxidation and reduction. Electron Carriers involved in the oxidation of fuel molecules. Oxidative phosphorylation and regulation of ATP production. Inhibitors of electron transport chain. Uncouplers of oxidative phosphorylation.

**2. Metabolism of Carbohydrates:**

Digestion, Absorption, and Transport of Carbohydrates. Glycolysis, Citric acid Cycle. HMP pathway. Uronic acid pathway. Gluconeogenesis. Glycogenesis, Glycogenolysis, Photosynthesis and their control. Regulation of carbohydrate metabolism.

**3. Metabolism of Lipids:**

Digestion and absorption of Lipids. Detailed Synthesis and Oxidation of fatty acids. Involving of Acyl carrier protein and Carnitine carriers. Metabolism of essential fatty acids and their metabolic disorders. Control of fatty acid Metabolism. Ketone Bodies. Phospholipids, steroids and Prostaglandins.

**4. Endocrine system:**

Mechanisms of action of hormones. Chemistry, Metabolism and Biological functions of Pancreatic, Pituitary, Gonadal, Adrenal, Thyroid, Parathyroid, Intestinal and Renal hormones. Pheromones. Hormonal control mechanisms.

**5. Metabolism of Amino acids and Proteins:**

Digestion and Absorption of Proteins. Biosynthesis of essential amino acids. Degradation of amino acids, Urea Cycle Decarboxylation, transamination and deamination reactions of amino acids and their importance. Creatine and creatinine synthesis and secretion.

**6. Metabolism of Nucleic Acids:**

Biosynthesis and Catabolism of Purines and Pyrimidines. Biosynthesis of nucleotides. Disorders linked to serum urate levels. Synthesis of RNA and splicing.

**RECOMMENDED BOOKS:**

1. Principles of Biochemistry by Lehninger AL, Nelson DL and Cox MN, 2000 Pub: Worth Publishers
2. Biochemistry by Lubert Stryer 2006 Pub: Freeman and Company
3. Biochemistry by Voet, and Pratt, 2004, John Wiley and Sons Inc.
4. Lippincott's Biochemistry by Champe.P C; Harvey. R. A and Ferrier. D. R. 3rd ed., 2004 Pub: J. b. Lippincott Company
5. Harpers Biochemistry, 27th ed. 2006 Pub: McGraw Hill Inc.

**Biochemistry (Additional Written) Paper II-D****SYLLABUS OUTLINE:****1. Biochemistry of Body Fluids:**

General composition of Blood, blood plasma, blood proteins, formed elements of blood. Biosynthesis and metabolism of Porphyrin and Hemoglobin. Gaseous transport. Coagulation of blood. Normal and Abnormal composition of Urine and its Biochemical effects. Composition of CSF.

**2. Immunochemistry:**

The immune system. Detailed structure, chemistry and synthesis of immunoglobulins. Myeloma and hybridoma immunoglobulins. Immungenes. Complement system. Inflammatory process. Peripheral leucocytes and Macrophages. Abnormalities of the immune system.

**3. Vitamins in health and disease:**

Water soluble and fat soluble vitamins. A discussion of the occurrence, chemistry, metabolism, physiological functions, deficiency symptoms and requirements of vitamins A, B-Complex, C, D, E and K.

**4. Physical Techniques used in Biochemistry:**

General methods for extraction, fractionation and purification of proteins. Principles of chromatography, Gel filtration, ion-exchange chromatography, affinity chromatography and gas chromatography. HPLC. Polyacrylamide and agarose gel electrophoresis, SDS PAGE, Immunoelectrophoresis. Immunological techniques including RIA, ELISA, Immunohistochemistry, Electrofocussing. Gradient centrifugation. Ultra filtration. Lyophilization. Electron microscopy. Radioisotopes and their applications in Biochemistry. X-ray diffraction

**5. Industrial Biochemistry:**

Use of Prokaryotes and Fungi in industry. Industrial production of Ethyl Alcohol, Vinegar, Lactic acid and monosodium Glutamate (MSG) using microorganisms. Bacterial application in food industry i.e. use of bacteria in processing and preserving of milk and meat. Bacterial use in other industries as washing powders,

**6. Minerals:**

Discussion of micro, macro and alien metals; their occurrence, physiological functions, deficiency symptoms, daily requirement and their metabolism.

**7. Physiological Chemistry:**

Structure and detoxification function of liver. Structure of Kidney with special reference of excretion and detoxification function. Muscular contraction and relaxation. Nerve conduction and action potential. Ionization of water, weak Acids and weak Bases. Buffering against pH changes in Biological systems. Water metabolism and acid base balance.

**8. Molecular Biology:**

DNA as a genetic material. Eukaryotic chromosomes. Genes and mutational units. Replication, transcription and translation. Protein Synthesis and Genetic code. DNA repair and recombination. Restriction enzymes. Regulation of gene expression in Prokaryotes & Eukaryotes and Operon model. Constitutive, repressed and induced enzymes. Plasmids, bacteriophages, cosmids. Methods of recombinant DNA, Viruses. RNA Processing.

**9. Drug Metabolism and chemotherapy:**

Chemistry, metabolism and mechanism of action of antimalarials, antibacterials, antivirals and antifungal drugs. Drug resistance, Biochemical transformation of drugs. Anticancer drugs.

**10. Microbial Biochemistry:**

Microorganisms and their gross Classification, Bacterial growth and cultivation techniques. Identification of Microorganisms, Factors for the growth of microbes. Culture medias and their composition. Methods of Growth measurement, Growth under extreme environments. Mutation and protoplast fusion in cultures and its benefits. Gene transfer: transformation, transduction and conjugation. Bacteriophages.

**RECOMMENDED BOOKS:**

1. Principles of Biochemistry by Lehninger AL, Nelson DL and Cox MN, 2000 Pub: worth Publishers
2. Biochemistry by Lubert Stryer 2006 Pub: Freeman and Company
3. Biochemistry by Voet, and Pratt, 2004, John wiley and sons Inc.
4. Lippincott's Biochemistry by Champe.P C; Harvey. R. A and Ferrier. D. R. 3rd ed., 2004 Pub: J. b. Lippincott Company
5. Harpers Biochemistry, 27th ed. 2006 Pub: McGraw Hill Inc.
6. Fundamentals of Microbiology (1994) E. Alcano Pub: the Benjamin/Cummings Publishing Company.
7. A Biological Guide to Principles and Techniques of Practical Biochemistry by Bryan L. Williams and Keith Wilson Pub: Edward Arnold.

**Biochemistry (Practical) Paper III-D****SYLLABUS OUTLINE:****1. Enzymes:**

Isolation of enzyme from different sources, study of different factors like temperature, pH, Concentration of substrate on the properties of Alkaline Phosphatase and LDH. Determination of the kinetic parameters of these enzymes and their mode of inhibition using UV / Visible Spectrophotometer.

**2. Vitamins:**

Estimation of Vitamin A, B1, B2, C and D in food materials by chemical methods and HPLC.

**3. Urine Analysis:**

Analysis of organic constituents in normal and abnormal human urine.

**4. Blood Analysis:**

Analysis of blood constituent like, Calcium, Phosphate, Sugar,Urea, creatine, Biliurbin, Cholesterol, Triglycerides by chemical methods, flame photometry and atomic absorption spectroscopy.

**5. Urine Analysis:**

Analysis of Inorganic constituents in normal and abnormal urine by atomic absorption spectrometry, flame photometry and titration methods.

**6. Blood Analysis:**

Analysis of inorganic constituents of blood like , sodium, potassium etc by flame photometry. Estimation of organic constituents like Uric acid, serum proteins, haemoglobin etc by chemical methods.

Estimation of Clinically important enzymes like alkaline phosphatase, acid phosphatase, SGPT, SGOT, creatine kinase, etc using their specific assay methods.

**(a) Cell structure:**

Study of cell structure by light microscope. Growth of Bacteria and its growth curve.

**(b) Separation techniques:**

Gel filtration of proteins, Separation of Blood proteins by Polyacrylamide gel electrophoresis.

**RECOMMENDED BOOKS:**

1. Modern Experimental Biochemistry by R. F. Boyer 3rd ed, 2000, Pub: pearson Education Inc.
2. Practical clinical Biochemistry by Varley. Pub: CBS publisher
3. An Introduction to Practical Biochemistry By D. T. Plummer 3rd ed. (1987) Pub: McGraw Hill
4. Fundamentals of Microbiology. By E. Aicamo 1994 Publisher; Benjamin- Cummings Publishing Co.

**M.Sc. (Part-II)****Environmental Chemistry (Written) Paper – IV****SYLLABUS OUTLINE:****1. Introduction:**

History and significance of environmental degradation, impact of the modern life-style on environmental quality, resource dep} at environmental conservation and sustainability poverty and environmental degradation, environmental education , institutions for the protection of environment, inter-disc nature of environmental studies, environmental segments.

**2. Atmospheric pollution:**

Importance of air, nature and composition of atmosphere, temperature and pressure profi of different layers of the atmosphere, common air pollutants and their sources, oxides of C, N, and S hydrologic cycle, green house effect and global warming, stratospheric ozone depletion, vehicular emissions, particulate matter and aerosols, airborne lead, acid rain and its impats, photochemical smog, photochemistry of the atmosphere, role of hydroxyl radicals, indoor air quality.

**3. Water pollution and water treatment:**

Importance of water, physical and chem. Properties of water, criteria for water quality, BOD and COD, sources of water pollution (industrial, agricultural, municipal and natural), fertilizers, pesticides, detergents, heav metals, bio-accumulation and bio-impliflcat primary, secondary and advanced treatment of water.

**4. Land pollution:**

Importance of soil, nature and composition of soil, macro and micro-nutrients in soil, soil erosion, pH of soil and nutrients availability, on-exchange in soil, sources of soil pollution (industry, agrochemicals, mining, muniopal waste, littering), reclamation of soil.

**5. Chemicals in the Environment and their impact:**

Chemical speciation, heavy metals, persistent organic pollutants, aflatoxins, PCB's, pesticides and detergents, house hold chemicals, solvents. Impact of chemicals on human health, crops and vegetation, buildings and monuments, aquatic life, biodiversity, visibility, concept of green chemistry.

**6. Monitoring of Environmental Pollution and Legislation:**

Principle, applications of analytical techniques for monitoring of pollution with special reference to OC, HPLC. – UV and IR spectrometry, Atomic absorption spectroscopy. Legislation aspects of environmental pollution, international standards regarding environmental pollution.

**BOOKS RECOMMENDED:**

1. Kumar. Environmental Chemistry, Wiley Eastern, New Delhi.
2. J.W. Moore & EM. Moore, Environmental Chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental Chemistry, Prentice Hall, Delhi.
4. K. Banerji, Environmental Chemistry, Tata Publisher, Delhi.
5. Stanley E. Manahan, Environmental Chemistry, Brooks, California.
6. Neil, P.O. Environmental Chemistry, Chapman, London.
7. Baird, C. Environmental Chemistry, Freeman, New York.