

INSTITUTE OF CHEMICAL SCIENCES

UNIVERSITY OF PESHWAR

Syllabus

M.Sc. CHEMISTRY (PREVIOUS) CONVENTIONAL SYSTEM

1 There shall be four theory papers each of 100 marks and four practical papers of 50 marks each.

THEORY

Paper #	Title of the Paper	Marks
<i>I</i>	<i>Maths & Physical Chemistry</i> 100	
<i>II</i>	<i>Organic Chemistry</i> 100	
<i>III</i>	<i>Inorganic Chemistry</i> 100	
<i>IV</i>	<i>Analytical Chemistry/Biochemistry/ Applied Chemistry/Fuel Chemistry.</i> 100	

PRACTICAL

<i>Physical Chemistry Practical</i>	50
<i>Organic Chemistry Practical</i>	50
<i>Inorganic Chemistry Practical</i>	50
<i>Analytical Chemistry/Biochemistry/</i>	50

Applied Chemistry/Fuel Chemistry Practical

Total Marks

600

2 Paper-I

MATHEMATICS FOR CHEMISTS/PHYSICAL CHEMISTRY

{Maths:

25 Marks}

Marks: 100

{Physical Chemistry: 75 Marks}

THEORY

Mathematics for Chemist

1. Large and small numbers, exponents and radicals.
2. Functions and their graphs.
3. Permutations and combinations.

4. Binomial theorem.
5. Trigonometric functions, graphs of logarithmic and trigonometric functions.
6. Differential calculus; rules for differentiation, graphical significance of differentiation, Successive differentiation, partial differentiation, solution of the problems of differential calculus found in the physical chemistry text book.
7. Integral calculus; theory, rules, integration between limits, integration by partial fractions, solutions of the problems of integral calculus found in the physical chemistry text books.

8. Infinite series, Maclaurin series, Taylor series, Fourier series.

Physical Chemist

1. numerical values for molecular energies and molecular speeds, Maxwell-Boltzmann law of **The kinetic molecular theory of gases**

The kinetic molecular gas model, the pressure of a gas, kinetic energies and temperature,

distribution of molecular velocities in one dimension, distribution of molecular velocities in three dimensions, the mean free path, collision diameter, and collision numbers, viscosity, theory of non-ideal behavior, Vander Wall's equation, the critical point and the law of corresponding states.

2. **Energies of molecules**

Categories of thermal energies of molecules of gases, the translational energies of a molecule of an ideal gas, the allowed rotational energies of molecules of a gas, the vibrational energies of gas phase molecules. Electronic states of molecules, the partition function, three dimensional translational energy of a mole of a gas, rotational and vibrational motion of molecules, thermal energy due to translational motion of a mole of gas, thermal energy due to rotational motion of the molecules of a gas, thermal energy due to vibration motion of molecules.

3. **Atomic structure**

Nature of light, atomic spectra, the wave nature of particles, wave mechanics and the Schrodinger equation, a one dimensional illustration of the Schrodinger equation, a particle in one dimensional square potential well. A three dimensional illustration of the Schrodinger equation, the cubic potential well problem. The use of angular momentum to impose quantum restrictions.

4. **Thermodynamics**

First, second and third laws of thermodynamics; their importance and applications. Various thermodynamic functions and their relation with each other, experimental measurements. Partial molal quantities and their determination. Free energy and equilibrium constant. Clausius-Clapeyron equation. Gibbs-Helmholtz equation.

5. **Electrochemistry**

Conductance in solutions, Derivation of Debye-Huckel and Onsager equation of conductance. Debye-Huckel limiting law for strong electrolytes, its derivation and applications. Activity coefficients, and their uses.

6. **Chemical kinetics**

Rates of chemical reactions. Rates equations for first second and third order. Rate of gas phase reactions. Gas-phase collisions between molecules of different types. Nature, life time and reactions of gas-phase, Free-radical intermediates. Reaction mechanisms and rate laws, the stationery state method.

7. **Surface chemistry**

Classification of adsorption of gases on solids. The adsorption isotherm. The Langmuir adsorption isotherm. Nature of the adsorbed state. Heterogeneous catalysis.

PRACTICAL **PHYSICAL CHEMISTRY**

Marks: 50

1. Determination of specific rate constant and activation energy for 1st order reaction
2. Determination of specific rate constant and activation energy for 2nd order reaction
3. Evaluation of thermodynamic quantities;
(i) Entropy, (ii) Heat content by calorimetric method
4. Refractometry
5. Saccharimetry
6. Molecular weight determination by cryoscopic method
7. Molecular weight determination by ebullioscopic method
8. Conductance measurement

9. Conductometric titration
10. Determination of transport number
11. Buffer solutions and pH measurements
12. Measurement of standard emf of a cell
13. Determination of equilibrium constant from emf measurement 14.
Molecular weight determination of high polymers
15. Potentiometric titrations
16. Colorimetry

BOOKS RECOMMENDED:

Mathematics:

1. Hirst, D.M, Mathematics for Chemists, Macmillan, London.
2. Ayrus, J. F, Theory and Problems of Differential and Integral Calculus, Schuam:
Outline Series, McGraw Hill, Singapore.
3. Marsden, J, and A.Weinstein, Calculus, the Benjamin/Cummings Pub. Co.
4. Francis, P.G, Mathematics for Chemistry, Chapman and Hall, London.

Physical Chemistry

Theory

1. Barrow, G. M, Physical chemistry, McGraw Hill, Singapore.
2. Atkins, P.W, "Physical Chemistry" 6th Ed. W.H. Freeman and Co., New York (1998).
3. Alberty, R, "Physical Chemistry", John Wiley and Sons (1987).

Practical

1. Daniel, F, and etal, Experimental Physical Chemistry, McGraw Hill, New York.
2. Findlay, A, and Kitchner, J.A, Practical Physical Chemistry, Longman, Green and Co.
3. Shoemaker, D.P, and Garland, J.A, Experiments in Physical Chemistry, McGraw Hill, New York.

THEORY

Marks: 100

1. Nomenclature and literature of organic chemistry 2. A brief introduction to chromatographic methods

Column, paper and thin layer chromatography, paper electrophoresis, Gas-liquid Chromatography.

3. Chemical bonding in organic chemistry

Localized chemical bonding, de-localized chemical bonding, aromaticity, resonance, hyper-conjugation and tautomerism.

4. Stereochemistry

Optical isomerism and optical activity, geometrical isomerism, conformational analysis.

5. Organic acid and bases 6. Organic reaction mechanisms

Mechanisms and methods of determining them, effects of structure on reactivity, aliphatic nucleophilic substitution, aromatic electrophilic substitution, aromatic nucleophilic substitution and elimination reactions.

7. An elementary introduction to spectral methods of analysis I.R.,

U.V., N.M.R., and Mass Spectrometry.

Practical:

Marks: 50

1. Laboratory basic techniques

Determination of boiling points of organic liquids by simple distillation, determination of melting points of organic compounds, re-crystallization of the crude Organic compounds.

2. Organic syntheses

Synthesis of nitrobenzene from benzene & nitrating mixture, synthesis of m-dinitrobenzene from nitrobenzene from the previous experiment), synthesis of Benzoin from benzaldehyde (Benzoin Condensation), synthesis of benzil from the crude benzoin (from the previous experiment), synthesis of benzylic acid from benzil (from the previous experiment).

5

3. Chromatographic techniques

Separation of ink pigments by ascending paper chromatography, separation of ink pigments by descending paper chromatography, separation of amino acids by ascending paper

chromatography, separation of amino acids by descending paper chromatography, separation of ink pigments by T. L.C., separation of amino acids by T. L. C.

4. **Organic compounds analyses:**

To analyse the organic compounds (Analysis of at least three known & three unknown Compounds).

BOOKS RECOMMENDED:

Theory

1. Jerry March, Advanced Organic Chemistry (Reactions, Mechanism and Structure). International Student Edition, McGraw-Hill.
2. Henry Rakoff & Norman C. Rose, Organic Chemistry, Collie Macmillan, student edition.
3. Cram, D.J, & Hammond, G.S, Organic chemistry, McGraw-Hill.
4. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson Edu, India.
5. Morrison, R.T, & Boyd, R.N, Organic Chemistry, Allyn and Bacon Inc.. Bostan.
6. Robert, J. D, & Casserio, M.C. Basic Principles of Organic Chemistry, Longman, London.
7. Nasir-ud-Din. Introduction to Acids and Basis, 1995.
8. Nasir-ud-Din, Introduction to Stereochemistry, 1995.
9. Nasir-ud-Din, Introduction to Chromatography, 1994.
10. Nasir-ud-Din, Introduction to Laboratory Manners, Safety Precaution and First Aid, 1996.
11. Nasir-ud-Din. Introduction to Nomenclature of Organic Compounds, 1998.

Practical

1. Vogel, A. I, Textbook of Practical Organic Chemistry, Longman, London.
2. Clarke H. T, A Handbook of Organic Analysis (Qualitative and Quantitative), London.
3. Hodgman, C. D, and et al., A Handbook of Chemistry & Physics.

THEORY**I. Electronic configuration and atomic spectra**

The four quantum numbers and their significance, the Aufbau Principle, many electron atoms. Russell Saunders coupling, J.J coupling schemes. Terms and term symbols, term symbols and their applications to the interpretation of spectra.

2. Coordination compounds

Application of various theories of chemical bonding to coordination compounds (VBT, CFT, MOT), thermodynamic, kinetic, magnetic and spectral properties.

3. Acceptor complexes

Chemistry and structure of the carbonyls and their derivatives, cyclopentadienyl, nitrosyls, halides and hydrides of transition metals with reference to theories of bonding.

4. Electron transfer processes

(a) Acids and bases; soft and hard acid base concept, detailed treatment and applications in chemistry, acid base catalysis, Heterogeneous and homogenous catalysis.

(b) Redox reactions; redox potentials, redox indicators, relationship between acid base behavior and oxidation reduction reactions.

5. Non-aqueous solvents

Classification of solvents, types of reactions in solvents, effect of Physical and chemical properties of solvents, pH measurements in non-aqueous media, chelation in non-aqueous media, detailed study of liq NH_3 , liq SO_2 and liq. HF. .

6. Chemistry of f-block elements

(a) Lanthanides; position in the periodic table, general characteristics, occurrence, extraction and general principles of separation.

(b) Actinides; electronic structure and position in the periodic table, general characteristics. Nuclear Reactions.

PRACTICAL INORGANIC CHEMISTRY

Marks:50

1. Semi micro qualitative analysis of an inorganic mixture containing six radicals including Interfering and insoluble.
2. Preparation of at least six inorganic compounds in pure state using different techniques of syntheses such as substitution, oxidation reduction etc.

3. Estimation of the following applying volumetric and gravimetric techniques.
- i. Ca^{2+} and Mg^{2+}
 - ii. Fe^{3+} and Al^{3+} iii. Cu^{2+} and Ni^{2+}
 - iv. Cu^{2+} and Zn^{2+}
4. Separation of cations by ion exchange chromatography

BOOKS RECOMMENDED:

Theory:

1. Cotton, F.A, & Wilkinson, Advanced Inorganic Chemistry, Interscience Publishers, N.Y.
2. Huheey, J. E, Inorganic Chemistry, Harper & Row, N.Y.
3. Cotton, F .A, and Wilkinson, Basic Inorganic Chemistry, John Willey, N. Y.
4. Waddington, T.C, Non-aqueous Solvents, Nelson Ltd, Canada.
5. Day & Selbin, Theoretical Inorganic Chemistry, Reinhold, San Francisco.
6. Jolly, W.L, Modern Inorganic Chemistry, McGraw-Hill, New York.
7. Budsalo and Johnson, Co-ordination Chemistry, Benjamin Inc.
8. Sharp, A.G, Inorganic Chemistry, E. L.B.S., London.
9. Ansari, A.R, Fundamentals of Inorganic Chemistry, Karachi University.
10. Zaffar Iqbal, Pi acceptor ligands, University Grants Commission, Islamabad.
11. Anil Kumar, A Textbook of Inorganic Chemistry, John Wiley, New Delhi.

Practicals:

1. Vogel, A.I, Textbook of Quantitative Inorganic Analysis, Longman, Green and Co.
2. Vogel, A.I, A Textbook of Macro and Semi micro Qualitative Inorganic Analysis, Longman, Green & Co:

Paper IV: 1ST ALTERNATIVE: ANALYTICAL CHEMISTRY

THEORY

1. **Fundamental concepts of analytical chemistry**
Solutions, electrolytes, chemical units, stoichiometric relationships.
2. **Theory of errors:**
Accuracy, precision and their presentation, error, its types and their manipulation. Significant Figures.

3. **The Law of mass action and its applications:**

Weak electrolytes, weak acids/bases, complex formation, buffer solutions, buffer capacity, Handerson Hasselbach equation, activity coefficient and its calculation. Hydrolysis of salts and pH calculation.

4. **Gravimetric analysis:**

Solubility of precipitates, formation and particle size of precipitates, co-precipitation and post-precipitates, quantitative separations.

5. **Theory of indicators:**

Acid/base, redox and adsorption indicators.

6. **Theory of volumetric analysis:**

Titrimetry, acid/base titrations, precipitation analysis, complex formation titrations, oxidation reduction titrations.

7. **Absorption spectrophotometry:**

Bear-Lambert's law; applications and limitations, IR. UV and Visible Spectroscopy.

8. **Electrometric methods:**

Polarography, conductometry, potentiometry, amperometry, coulometry and electrogravimetry.

9. **Sampling:**

PRACTICAL ANALYTICAL CHEMISTRY

Marks: 50

1. Verification of Beer's law and its applications.
2. Flame photometry of alkali metals.
3. Acid-Base titrations and its applications to different commercial samples.
4. Determination of pK_a and pK_b of weak acid and base.
5. Potentiometric titrations; acid-base weak and strong acids and their mixture.
6. Conductometric titrations; acid-base weak and strong acids and their mixtures.
7. Redox titration and its applications.
8. Complexometric titrations and its applications.
9. Back titrations.

BOOKS RECOMMENDED:

Theory

1. Christian, G.D, Analytical Chemistry, John Wiley and Sons.
2. Skoog, D. A, and West, D. M, Fundamentals of Analytical Chemistry, Reinhold, New York.
3. Dick, J.G., Analytical Chemistry, McGraw-Hill, Tokyo.

4. Kolthoff, I.M., Sandell, Text book of Quantitative Inorganic Analysis, Macmillan and Co, New York.
5. Khokar, S.M, Basic Concepts of Analytical Chemistry, Wiley, New Delhi.
6. Bates, R.G, Determination of pH Theory and Practice, John Wiley, New York.
7. Gordus, A.A, Theory and Problems of Analytical Chemistry, McGraw-Hill, New York.
8. Fifield, F.W, and Kealy, D, Principles and Practice of Analytical Chemistry, I.T.B, London.

Practical

1. Christian, G. D, Analytical Chemistry, John Wiley and Sons.
2. Reilley, C. N., Sawyer, D.T, Experiments for Instrumental Methods, McGraw Hill, New York.

Paper-IV: 2nd ALTERNATIVE: BIOCHEMISTRY

THEORY

Introductory Biochemistrv

- I. Physical principles of biochemistry, cell structure and its functions.
2. Chemistry of carbohydrates, lipids, amino acids, proteins and nucleic acids. and their biological significances.
3. A brief introduction to the nature of enzymes and co-enzymes.
4. A discussion of the occurrence. chemistry. metabolism and physiological functions. deficiency symptoms and requirements of vitamins A, B Complex, C.D.E and K
5. Introduction to intermediary metabolism.
6. Biological oxidations reductions including respiratory carrier and oxidative phosphorylation.
7. Digestion and absorption of food.
8. **Metabolisms**
 - i) Carbohydrates; transport of sugars into cells, glycolysis, HMP pathway and its significance, citric acid cycle. Gluconeogenesis. Photosynthesis.
 - ii) Lipids; knoops -oxidation theory, fatty acid catabolism, biosynthesis of triglycerides, phospholipids, sterols and bile acids, formation and metabolism of ketone bodies.
 - iii) Proteins and amino acids; decarboxylation, transamination, and deamination reactions, urea cycle, creatine and uric acid synthesis, biosynthesis of proteins.
inter relationship between carbohydrates, lipids and protein metabolism.

PRACTICAL

Marks: 50

- I. Study of cell structure under light microscope.
2. Qualitative test for carbohydrates; distinction between pentoses and hexoses, aldohexoses and ketohexoses, reducing and non-reducing sugars and mono and disaccharides. Estimation of reducing sugars, specific oxidation of sugar by periodate. Preparation of glycogen from liver, acid and enzymic hydrolysis of polysaccharides, estimation of glucose in a mixture of monosaccharides.
3. Tests for fats, sterols and phospholipids, estimation of cholesterol.
4. Hydrolysis of proteins and qualitative tests for amino-acid estimation of proteins by Biuret, Folin-Ciocalteu and Kjeldahl's methods. Fractionation of proteins by precipitation with salt and organic solvents. Preparation and properties of cytochrome C. Determination of free amino group of proteins, sequence determination of tripeptides.
5. Estimation of ascorbic acid, vitamin A and D.

RECOMENDED BOOKS:

Theory

1. Lehninger, A. K, Principles of Biochemistry, Worth Publishers Inc., London.
2. Stryer, L, Biochemistry, Freeman and Company, New York.
3. West, W. R., Todd, H.S, Textbook of Biochemistry, Macmillan, London.
4. Chaudhry, K, Biochemical Techniques, Cand Publication.

Practical

1. Plummer, D. T, Introduction to Practical Biochemistry, McGraw-Hill, London.
2. Daldwin, E, Practical Physiological Chemistry, Cole's Cambridge.

Paper IV:

THEORY

Marks: 100

1. **Unit operations:**

Working and Industrial application of the following:

Crushing.. grinding, size separation, filtration, evaporation and distillation (mathematical treatment excluded).

2. **Fuels:**

Natural gas purification, manufacture and synthesis of producer gas, carbonization of coal. fractional distillation of crude petroleum, refining of petroleum fractions.

3. Water Purification and softening of water.

4. Sugar industries.

5. Paper and pulp industries.

6. Fats. oils and soap industries.

7. Leather Industries.

8. Fermentation Industries.

9. Fertilizer Industries.

10. Cement and Glass Industries.

PRACTICAL

Marks: 50

Chemical Examination of water, fertilizer, brass. bronze. steel. cement, soap and coal.

BOOKS RECOMMENDED:**Theory:**

1. Badger, W.L, & Banchemo, J.T, Introduction to Chemical Engg., McGraw-Hill, New York (1955).
2. Shreve, R.N, "The chemical process, industries, 5th Edition, McGraw-Hill, New York (1984).
3. Reigel, E. R, Industrial Chemistry, 5th Edition, Reihold Publishing Co, New York (1997).

4. Vogel, A.I, Quantitative Inorganic Analysis, 3rd Edition, Longman Green and Co, London (1961).
5. Coulson & Richard Son, Chemical Engineering, 1st Ed. (1985).

Practicals:

6. Grant, J, Chemical Analysis (1947).
7. Mahin, E.D, Chemical Analysis, McGraw-Hill. New York (1932).

Paper-IV: 4TH ALTERNATIVE: FUEL CHEMISTRY

Marks 100 **THEORY**

I. Chemistry of coal:

Origin of coal, classification of coal, petrology of coal, physical, chemical and mechanical properties of coal, cleaning of coal by gravity separation, float and sink, and froth flotation methods, storage of coal. Coal briquetting, carbonization of coal. separation of tar, ammonia, Light oil and sulphur compounds from coke oven gas.

2. Chemistry of Hydrocarbon Fuels

Origin and nature of crude petroleum and natural gas. preliminary treatment of crude petroleum and natural gas, fractionation of crude petroleum introduction to cracking and reforming of petroleum properties, uses and refining of commercial petroleum products such as diesel, gasoline, kerosine fuel oil, lubricating oil and greases.

3. Alternate Fuels:

Bio-fuels, alcohol and hydrogen as alternate fuels, liquid fuels from oil shale and tar sand. nitrogen hydrides as alternate fuel.

PRACTICAL

Marks: 50

1. Analysis and testing of coal and coke determination of moisture, volatile matter, ash and fixed carbon in coal (Proximate analysis), determination of carbon, hydrogen, nitrogen, sulphur, chlorine and oxygen in coal (ultimate analysis), determination of forms of sulphur in coal.
2. Analysis and testing of hydrocarbon fuels, determination of specific and API gravity of petroleum fractions by bottle as well as by hydrometers, estimation of carbon residue in petroleum products (Conradson method), ash content estimation in petroleum products, determination of sulphated ash in lube oil, estimation of water, sediments and oil in crude oil by centrifuge method, determination

of aniline point, diesel index and approximate cetane number of diesel fuel, determination of cloud and pour point of Lube-oil. estimation of asphalt in road samples.

BOOKS RECOMMENDED:

Theory

1. Harker, J.H, and Backurst, J.R, Fuel and Energy, Academic Press, London & New York.
2. Wilson, P.J, and Wells, J.H, Coal, Coke and Coal Chemicals, McGraw-Hill book company, London.
3. Hobson, G.D, Modern Petroleum Technology Part-I, John Wiley and Sons, New York.
4. John Twidell and Tony Weir, Renewable Energy Resources, E and F. N., Spon London, New York.

Practical

1. Harker, J.H, and Backurst, J.R, Fuel and Energy, Academic Press, London & New York.
2. Karr Jr. C, Analytical Methods for Coal and Coal Products, Academic Press, London.
3. Methods for Analysis and Testing, **IP** Standard for Petroleum and its Products Part-I, Heyden and Sons, London.

INSTITUTE OF CHEMICAL SCIENCES

UNIVERSITY OF PESHWAR

Syllabus

M.Sc. CHEMISTRY (Final) CONVENTIONAL SYSTEM

INSTITUTE OF CHEMICAL SCIENCES UNIVERSITY OF PESHAWAR

Syllabus:

M.Sc. (Final)

Field of Specialization:

Physical Chemistry

Theory

Paper No.	Title of the Paper	Marks
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V	Environmental Chemistry	75
VI	Quantum Chemistry and Spectroscopy	100
VII	Statistical Mechanics Thermodynamics and Solution Thermodynamics	100
VIII	Surface Chemistry and Advanced Chemical Kinetics	100

Practicals

(i)	Environmental Chemistry Practicals	25
(ii)	Advanced Physical Chemistry Practicals or Research Project	100
(iii)	Instrumental Methods of Analysis Practicals	100

Total Marks:

600

2 Paper-V: ENVIRONMENTAL CHEMISTRY
(For Students of All Disciplines)

Marks:75

1. Fossil fuels and energy sources

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

2. The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulates, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemicals smog, airborne lead, control of automobile emissions.

3. Soils and mineral resources

Estimating reserves of mineral resources of earth. Extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

4. Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W, & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan S.E, Environmental Chemistry, Brooks, California.

Paper VI: QUANTUM CHEMISTRY AND SPECTROSCOPY

Marks: 100

1. Quantum chemistry

1.1 Some basic mathematical concepts

Operator, complex numbers, well behaved functions, probability functions and average values.

1.2 The Schrodinger formulation of quantum mechanics

Some fundamental concepts used in quantum mechanics (e.g. dynamical variables, state functions). The laws of quantum mechanics, some important corollaries of the laws of quantum mechanics, the quantum mechanical treatment of chemical systems, atomic units.

1.3 Some solutions of the steady state Schrodinger equation

- I. System with constant potential energy, free particles, particles in boxes, systems involving potential wells of finite height.
- II. System for which the potential energy is not constant, the one dimensional harmonic oscillator. the hydrogen molecular ion H_2^{2+}

1.4 Angular momentum in quantum mechanics:

The angular momentum of a single particle, the angular momentum of systems composed of many particles, spectroscopic notations based on angular momentum.

2. Spectroscopy

2.1 Introduction to theoretical treatment of molecular system

Absorption and emission of radiations, general introduction, electromagnetic radiations, wavelength units, different spectral radiations, spectrophotometry.

2.2 The vibrational spectra of diatomic molecules

Vibrations of various types of particles, their potential energy functions, harmonic and anharmonic oscillators.

3.3 Rotational vibration spectra

Rigid rotor-harmonic oscillate model, coupling of rotations and vibrations, parallel and perpendicular bands of spectra.

3.4 Rotational spectra of molecules

Rotational spectra of rigid and nonrigid rotors, selection rules, symmetric and asymmetric top molecules.

3.5 Electronic spectra of diatomic and polyatomic molecules

The vibration and rotational structure of electronic bands, electronic states of atoms and diatomic molecules, electron orbital in diatomic molecules, potential energy curves for electronic state of diatomic molecules. non-radiative processes, fluorescence.

BOOKS RECOMMENDED:

1. Kauzman, W, Quantum Chemistry, Academic Press, New York.
2. Bockhoff, F. J, Elements of Quantum Theory, 2nd Edition, Addison, London.
3. Barrow, G.M, Introduction to Molecular Spectroscopy, McGraw-Hill, New York.
4. Barrow, G.M, The Structure of Molecules, Benjamin, New York.
5. Herzberg, G, Atomic Spectra and Atomic Structure, Dover Publications, New York.
6. Herzberg, Spectra of Diatomic Molecules, Dover Publications, New York. 7. Banwell, C.N, Fundamentals of Molecular Spectroscopy, McGraw-Hill, New Delhi.

Paper-VII: STATISTICAL MECHANICS. THERMODYNAMICS AND SOLUTION THERMODYNAMICS

Marks:100

1. **Statistical distribution**
Permutations, Probability, Distribution of Molecules in energy states, most probable distribution.
2. **Partition Function**
Factorisability of partition functions, translational, vibrational, rotational, electronic and nuclear partition functions.
3. **Statistical thermodynamics**
The statistical formulation of the functions of thermodynamics, work, heat, enthalpy, heat capacity, entropy and free energy. The equilibrium constant.
4. **Some applications of Statistical thermodynamics**
The entropy of mixing ortho and para hydrogen, the entropy of hydrogen, the heat capacity of gases, the heat capacity of solids.
5. **Solution thermodynamics**
Liquid Solutions, Raoult's Law, heat of mixing, solubility of solid and gases, Henry's law, colligative properties of solutions, activities and activity coefficients and their measurement, statistical mechanics of non-ideal solutions.

BOOKS RECOMMENDED:

1. Kanfman, D. R, Advanced Concepts in Physical Chemistry, McGraw Hill, New York.
2. Moelwyn-Hughes E.A, Physical Chemistry, Pergamon Press, Oxford.
3. Wall, F.T, Chemical Thermodynamics, Freeman, San Francisco.

Paper-VIII: SURFACE CHEMISTRY AND ADVANCED CHEMICAL KINETICS

Marks: 100

1. **Surface chemistry**

Different forms of adsorption isotherms. Gas adsorption, Henry's equation, Gibbs adsorption equation and its applications. Change in free energy in adsorption. Energy of adsorption, Hydrogen bond in adsorption. Adsorption from solutions on the surface of solids. Influence of chemical nature of surface, dimension of adsorbent pores, temperature, solubility and properties on solutions of adsorption from solutions.

2. **Advanced chemical kinetics**

A review of common experimental methods and treatment of kinetic data. Temperature dependence of the rates of reactions. Opposing reactions. consecutive reactions, parallel reactions, chain reactions, different theories for finding reactionary rates (collision and transition state theories) and their comparison. Primary salt effect in ionic reactions.

BOOKS RECOMMENDED:

1. Gerasimov, Y.A, Physical Chemistry, Vol-I, Mir Publishers, Moscow.
2. Maron and Prutton, Principles of Physical Chemistry, McGraw:Hill, New York.
3. Frost, A.A, and Pearson, R.G. Kinetics and Mechanisms, John Wiley, New York.

PRACTICAL I: Environmental chemistry Practical

Marks:25

II: Advanced Physical Chemistry Laboratory or Research Project:

Marks: 100

1. Kinetic study of the halogenation of acetone.
2. Kinetic study of the inversion of cane sugar.
3. Radius of a molecule from viscosity measurement.
4. Heat of neutralization of a strong acid with a strong base.
5. Activity co-efficient of silver acetate from solubility measurement.
6. Determination of thermodynamic quantities for a reaction using electrochemical cell.
7. Determination of activity co-efficients and transport numbers using concentration cell.
8. Study of hydrolysis of aniline hydrochloride.
9. Determination of gram molecular volume of ethanol and its partial molar volume at 25° in dilute aqueous solution.
10. Determination of the dissociation constant of picric acid.
11. Kinetics of reaction of benzenediazonium chloride and water.
12. Kinetics of ionic reactions.
13. Determination of the precipitation value of NaCl, BaCl₂. AlCl₃ for arsenious oxide solution.
14. Determination of distribution co-efficient for benzoic acid in benzene and water.
15. Determination of transition point of sodium sulphate by thermodynamic method.
16. Fractionation determination of number of theoretical plates by distillation of benzene carbon tetrachloride mixtures using refractive index for analysis of reactions

III. Instrumental Methods of Chemical Analysis Practical

Marks: 100

1. Analytical Techniques of Polarography.
2. Anodic Stripping voltametry.
3. Potentiometry and conductometry.
4. Polarimetry.

5. Gas Chromatography.
6. Bomb calorimetry.
7. Flame spectrometry.
8. Light scattering studies.

7 BOOKS RECOMMENDED:

1. Shoemaker, D.P, and Garland, C, Experiments of Physical Chemistry, McGraw Hill, New York.
2. Lyalikova, Y.U, Physico-chemical Analysis, Mir Publishers, Mascow.
3. Reilley, C.M, Experiments for Instrumental Methods, A Laboratory Manual, McGraw-Hill, New York.

INSTITUTE OF CHEMICAL SCIENCES UNIVERSITY OF PESHAWAR

Syllabus:

M.Sc. (Final)

Field of Specialization:

Organic Chemistry

Theory

Paper No.	Title of the Paper	Marks
V	Environmental Chemistry	75
VI.	Heterocyclic Chemistry	100
VII	Oxidation/Reduction	100
VIII	Spectral Analysis of Organic Compounds	100

Practical

- (i) Environmental Chemistry Practicals 25
- (ii) Advanced Organic Chemistry Practical or Research Project 100
- (iii) Instrumental Methods of Analysis Practicals 100

Total marks: 600

9 Paper-V: ENVIRONMENTAL CHEMISTRY Marks:75

1. Fossil fuels and energy sources

Origin and development of coal, Origin and reserves of petroleum and natural gas, composition and classification of petroleum, petroleum refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

2. The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone. natural vs polluted air, particulate matter, analysis and control of particulates, sulphur oxides, effects of sulphur dioxides and particulates, other

industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemical smog. airborne lead, control of automobile emissions.

3. **Soils and mineral resources**

Estimating reserves of mineral resources of earth, extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen, organic matter in soil, soil nutrients, ion exchange in soils. soil pH and nutrients availability.

4. **Water and water treatment**

Unique physical and chemical properties of water, criteria of water quality, natural water eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. **The green revolution**

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W. & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan, S. E, Environmental Chemistry, Brooks, California.

1. Heterocyclic compounds

This will include the study of the following topics with special reference of their introduction, natural occurrence, physical properties, and structure; chemical properties and synthesis.

1.1 Three, four, five and six membered heterocyclic compounds with only one hetero atom (both saturated and unsaturated heterocyclic compounds).

1.2 Some compounds with more than two hetero atoms, purines, pteridines, triazolines.

2. Photochemistry, Woodward and Hofmann rule

2.1 Introduction, excitation and the excited state.

2.2 Intramolecular reactions of the olefinic bond.

2.3 Intramolecular reactions of the carbonyl group.

2.4 Intramolecular cycloaddition reaction.

2.5 Generalized Woodward and Hofmann rules for concerted reactions.

3. Natural products

3.1 Alkaloids

Introduction, classification, isolation procedures structural elucidation and chemistry of the following alkaloids: Caffeine, nicotine, and morphine.

3.2 Vitamins

Occurrence, isolation, deficiency diseases and structural elucidation of the following vitamins: A₁ B₁, B₂, B₁₂, C, D & E.

3.3 Steroids

General introduction, cholesterol and sex hormones.

BOOKS RECOMMENDED:

1. Finar, I.L, Organic Chemistry, Vol. 1, 6th Edition, ELBS, Longman Group Ltd, England.
2. Acheson, R.M, An Introduction to the Chemistry of Heterocyclic Compounds, 3rd edition, John Wiley and Sons, New York.
3. Bansal, R. K, Heterocyclic Chemistry, Wiley Eastern Ltd. Tokyo.
4. Coxon, J.M. and Halton, B, Organic Photochemistry, Cambridge University Press. England.

5. Depuy, C. H, and Orville S. Chapman, Molecular Reactions and Photochemistry, Prentice Hall, New York. 6 Finar, I.L, Organic Chemistry. 5th edition, vol.2, Longman Group Ltd. England.

Paper-VII: OXIDATION/REDUCTION

Marks: 100

1. Reductions

- 1.1 Catalytic hydrogenation and dehydrogenation, catalysts, solvents and equipment, reduction of functional groups, mechanism and stereochemistry, dehydrogenation reaction.
- 1.2 Metal hydride reductions and related reactions.
- 1.3 Hydroboration and related reactions.
- 1.4 Dissolving metal reductions and related reactions.

2. Oxidations

- 2.1 Oxidations with chromium and manganese compounds (Oxidation of alcohols, aldehydes, carbon-carbon double bonds, and carbon-hydrogen bonds in hydrocarbons).
- 2.2 Oxidation with per acids and other peroxides (oxidation of carbon-carbon double bonds, carbonyl compounds, amines and sulphides).
- 2.3 Other methods of oxidation (oxidation with periodic acid, lead tetracetate, mercuric acetate and selenium dioxide).

3. Organometallic Compounds

- 3.1 Properties, structure and synthetic applications of organometallic compounds of Li, Na, Mg, Zn, Cd, & Hg.

4. Reactive intermediates and molecular rearrangements

- 4.1 Carbonium ions, carbanions, free radicals, benzyne, carbene and nitrene.
- 4.2 Anionotropic, cationotropic rearrangements, and free radical rearrangements.

BOOKS RCOMMENDED:

1. House, H. O, Modern Synthetic Reactions, 2nd edition Benjamin Inc., California.
2. Jerry March. Advanced Organic Chemistry, 3rd Edition, McGraw Hill Book Co.

New York.

3. Andrew Streitwieser, Introduction to Organic Chemistry, 2nd edition.

"7 4. El-Ichi Negishi. Organic Chemistry, John Wiley and Sons, New York.

5. Mukherji, S. M, Singh, S.P, and Kapoor. Organic Chemistry, vol. III, John Wiley, New Dehli.
6. Milos Hudlicky, Oxidations and Reductions Inorganic Chemistry, Eliis Horwood Ltd, New York.
7. Norman, R.O.C, Principles of Organic Synthesis, Methuen and Co Ltd., New York.

Paper-VIII: SPECTRAL ANALYSIS OF ORGANIC COMPOUNDS

Marks: 100

1. Infra red spectroscopy

- 1.1 Molecular vibrations.
- 1.2 Mechanics of measurement
- 1.3 Applications of infrared spectroscopy.
- 1.4 Absorptions of common functional groups
- 1.5 Problems.

2. Ultraviolet spectroscopy

- 2.1 Mechanics of measurement
- 2.2 Electronic Excitations
- 2.3 Simple chromophoric groups
- 2.4 Conjugated systems
- 2.5 Systems of extended conjugations
- 2.6 Aromatic systems
- 2.7 Problems

3. **Nuclear magnetic resonance spectroscopy**
 - 3.1 Magnetic properties of nuclei
 - 3.2 Theory of nuclear resonance
 - 3.3 The chemical shift
 - 3.4 Spin-spin interaction
 - 3.5 Chemical exchange
 - 3.6 Mechanics of measurement
 - 3.7 Shielding mechanisms
 - 3.8 Correlations; Hydrogen band to carbon and other nuclei, complex spin spin interaction.
 - 3.9 A brief introduction of C^{13} NMR and resonance of other nuclei.
 - 3.10 Problems.
4. **Mass spectroscopy**
 - 4.1 Instrumentation and sample handling
 - 4.2 Basic aspects of mass spectrometry
 - 4.3 Fragmentation of positive ion
 - 4.4 Interpretation of the mass spectrum
5. **A brief introduction to the following topics**
 - 5.1 Polarimetry
 - 5.2 Optical Rotary Dispersion.
 - 5.3 Circular Dichroism
 - 5.4 Electron spin resonance

BOOKS RECOMMENDED:

1. Creswell, C. J, Runquist, A. O, and Campbell, M.M, Spectral Analysis of Organic Compounds, An Introduction Programmed Text, Longmann, London.
2. Williams, D.H, and Fleming, I, Spectroscopic Methods in Organic Chemistry, McGraw-Hill, London.
3. Cross, A.D, and Alen Jones, an Introduction to Practical Infrared Spectroscopy, Butterworths, London.
4. Jackman, L. M, Applications of NMR Spectroscopy Inorganic Chemistry, Pergaman, New York.

5. Silverstein, R.M, and Bassler, C, Spectroscopic Identification of Organic Compounds, John Wiley & Sons, New York.
6. John R. Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prentice-Hall, Inc., Englewood, Cliffs, New Jersey.
7. Derassi, Rotatory Dispersion, McGraw-Hill, New York.
8. Crabbe. Optical Rotatory Dispersion and Circular Dichroism. Holden day, New York.
9. Jerry March. Advanced Organic Chemistry, McGraw-Hill. New York.
10. Hill, H.C, Introduction to Mass Spectrometry, Heydens and Sons Ltd., London
11. Wingrove, A. S. and Caret, L.R, Organic Chemistry, Harper and Row, New York.

PRACTICAL

I. Environmental Chemistry Practicals Mark:25

II Advanced Organic Chemistry Lab or Research Project Mark:25

1. Many step synthesis of organic compounds. (To be organized by the teacher concerned).
2. Synthesis of organic compounds by "Named organic reaction" e.g
 - 2.1 Clemmensen reduction (Diethyl ether).
 - 2.2 Perkin reaction (phenyl acetic acid) 2.3 Friedel Crafts reaction (acetoacetic ester).
 - 2.4 Grignard reaction (triphenyl carbinol).

or

any other reactions depending upon the availability of chemical and equipment. In some of the above syntheses the students be asked to record the IR spectra of the starting material and the product of the reaction to follow the reaction and to identify the product.

3. **Isolation of natural products**
 - 3.1 Isolation of caffeine from tea leaves.
 - 3.2 Isolation of nicotine from tobacco leaves.
 - 3.3 Isolation of eugenol from clove oil.
4. **Quantitative analysis**

4.1 Estimation of aldehydes, ketones. and esters.

III. Instrumental Methods of Analysis Practical

Marks:100

1. Paper chromatography

- 1.1 Chromatography, ascending; the separation of the component of commercial inks.
- 1.2 Chromatography, ascending; separation of amino acids.
- 1.3 Chromatography, ascending; the separation and detection of amino acids in fruit juices.
- 1.4 Chromatography, descending; the separation and detection of amino acids in fruit juices.
- 1.5 Chromatography, two way, the separation and detection of amino acids in fruit juices or inks.
- 1.6 Chromatography, ascending; the recovery of substances from paper chromatography by elution.
- 1.7 Chromatography, descending; the recovery of substances from paper chromatography by elution.

2. Paper electrophoresis

- 2.1 Separation of ink pigments, dyes or indicators by paper electrophoresis.
- 2.2 Electrophoretic separation of amino acids in fruit juices.

3. Thin layer chromatography

- 3.1 Separation of ink pigments by thin layer chromatography
- 3.2 Separation of amino acids by thin layer chromatography.
- 3.3 The recovery by elution of substances from thin layer.

4. Column chromatography

- 4.1 Separation of 2,4-dinitrophenylhydrazones.

5. Refractometry

- 5.1 To find the one of sugar solution by refractometry.

6. Spectroscopy

- 6.1 To record the IR spectrum of a compound and interpret it.

- 6.2 To record a UV spectrum of a compound and find its extinction coefficient.
- 6.3 To find the concentration of glycine solution using Spectronic 20.
- 6.4 To record the optical rotation of a given organic compound.

BOOKS RECOMMENDED

1. Mann, F.G. and Saunders, B.G. Practical Organic Chemistry, Longmann, London.
2. Vogel, I, A textbook of Practical Organic Chemistry, Longmann, London.
3. Elivdige and Sammes, A Course in Modern Technique of Organic Chemistry, Butterworths, London.
4. Mikes, O, and others, Laboratory Handbook of Chromatographic Methods, Van Nostrand, New York.
5. Dannley, R.L., Cram, J.D, Experimental Organic Chemistry, The Macmillan Co. New York.
6. Addison Ault, Techniques and Experiments for Organic Chemistry, Holbrook Press, Boston.
7. Nasir-ud-din. Introduction to Chromatography, 1994.
8. Nasir-ud-din, Introduction to Laboratory Manners, Safety, Precaution and First Aid, 1996.
9. Nasir-ud-Din, Introduction to Fundamental Techniques in Chemistry, 1998.

**INSTITUTE OF CHEMICAL SCIENCES
UNIVERSITY OF PESHAWAR**

Syllabus:

M.Sc. (Final)

Field of Specialization:

Inorganic Chemistry

Theory:

Paper No.	Title of the Paper.	Marks
V	Environmental Chemistry	75
VI	Mechanism of Inorganic Reactions and Bio-Inorganic Chemistry	100
VII	Spectroscopy and Instrumental Methods of Analysis	100
VIII	Nuclear and Radio Chemistry	100

Practical

(i)	Environmental Chemistry Practicals	25
(ii)	Advanced Inorganic Chemistry Practical or Research Project	100
(iii)	Instrumental Methods of Analysis Practicals	100
	Total marks:	600

1. Fossil fuels and energy sources

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors. solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy. electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

2. The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulation, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemicals smog, airborne lead, control of automobile emissions.

3. Soils and mineral resources

Estimating reserves of mineral resources of earth. Extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, soil pH and nutrients availability.

4. Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W, & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan, S. E, Environmental Chemistry, Brooks, California.

Paper-VI: MECHANISM OF INORGANIC REACTIONS AND BIO-INORGANIC CHEMISTRY

Marks:100

1. Nomenclature

A review of the theories of coordinate bond; The VB theory, the CFT and its applications, the M.O.T (ligand field theory) critique of the theories, inertness and lability, VX, thermodynamic stability.

2. Ligand replacement reactions

D, ID, IA and A mechanisms, activation parameters, water exchange rates, formation of complexes from equations, acid and base hydrolysis, attack on ligands, ligand displacement reaction in square complexes, the trans effect, substitution reactions and mechanism of substitution in tetrahedral complexes.

3. Electron transfer processes

"Outer Sphere" reactions. The Merus theory, ligand-bridge (inner sphere) reactions, two electron transfer and redox reactions.

4. Metal ion catalysis of organic reactions

Hydrolysis reactions, transamination, aldol condensation, bromination, decarboxylation, radical with metal ions, synthetic oxygen carriers, aromatic ligands, quasiaromatic ligands, template reactions.

5. Bioinorganic chemistry

The biochemistry of iron, iron storage and transfer in bacteria, iron transport haemoglobin and myoglobin, nature of the haemo-dioxygen binding, model systems, cooperativity in haemoglobin, cytochromes, P 450 enzymes, iron sulphur protein, ferredoxins, haemoerythrins, the biochemistry of Zn, Cu, Co and alkaline earths.

BOOKS RECOMMENDED:

1. Cotton, F.A, and Wilkinson, S, Advanced Inorganic Chemistry, John Wiley and sons, New York.
2. Basolo, F, and Johnson, R, Mechanism of Inorganic Reactions, John Wiley and sons, New York.
3. Basolo, F, and Johnson, R, Coordination Chemistry, W.A.Benjamen, Row Publishers, New York.
4. Huheey, J.E, Inorganic Chemistry, Harper and Row Publisher, New York.
5. Jonson, D, Mechanism of Inorganic Reactions in Solutions, McGraw-Hill, London.
6. Gunther, G.L, and Elchhor, Bioinorganic, Allyn, Boston.
7. Tobe, M.L, Studies in Modern Chemistry.

Paper-VII: SPECTROSCOPY AND INSTRUMENTAL METHODS OF ANALYSIS

1. **Symmetry elements**

Symmetry operations, non-degenerate and degenerate representations, character tables, group theory, matrices tables and matrix representation.

2. **General introduction to spectroscopy**

Electronic absorption spectroscopy and its applications, spectra of transition metal complexes, applications of the principles related to electronic transition, structural evidence from electronic spectra, basic instrumentation of U.V. and visible.

3. **Vibration and rotation spectroscopy**

Infrared, Raman and microwave, applications of infrared and Raman spectroscopy to the determination of organic and inorganic structures, basic instrumentation of IR to application of group theory in IR and Raman for simple molecules.

4. **Nuclear magnetic resonance spectroscopy**

Theory and applications of NMR to structure determination.

5. **Emission Spectroscopy**

Origin of spectra, excitation methods, spectrographs, qualitative identification.

6. **Conductance Method**

Electrolytic conductivity, instrumentation, conductometric titrations, basic principles of polarography.

7. **Chromatography**

Paper chromatography, TLC, GLC, HPLC and ion exchange chromatography.

8. **Mass spectroscopy**

Theory and application to simple molecules.

BOOKS RECOMMENDED:

1. Drago, R. S, Physical Methods in Inorganic Chemistry, Van Nostrand Reinhold, New York.
2. Wiliard, M.H., Merrite, L.L, Dean, J.J.A, Instrumental Methods of Analysis, Van Nostrand, New York.
3. Banwale, C.N, Fundamentals of Molecular Spectroscopy, McGraw-Hill, New York.
4. Cotton, F.A, Chemical Application of Group Theory, John Wiley and Sons, New York.
5. Gassidy, H.G, Fundamental Chromatography, Interscience Publications, New York.
6. Helfforich, F, Ion Exchange, McGraw-Hill, New York.

Paper-VIII: NUCLEAR AND RADIO CHEMISTRY

Marks:100

1. Nuclear Reactions

Nature of nuclear reactions, nuclear reaction mechanism, nuclear cross sections, excitation functions, types of nuclear reactions, fission and fusion reactions photonuclear reactions, acceleration of charged particles; projectiles, linear accelerators.

2. Radioactive decay, detection and interaction of radiations

Half life and average life of radioactive species, types of radioactive equilibrium, units of radioactivity. Determination of half lives, radiation detection and measurements, Geiger Muller counters, scintillation counters. Interaction of radiation with matter, processes responsible for energy loss, energy range relationship, determination of alpha and beta particles range.

3. Applications of nuclear science

- A) Isotope as tracers in biological studies, applications in medicines; industrial applications.
- B) Radioactivity applied to analytical chemistry, analysis by natural radioactivity, by induced radioactivity (activation analysis), analysis by tracer methods.

BOOKS RECOMMENDED:

- 1. Friedlander, G.F., Kennedy, J.W, and Miller, J.M, Nuclear and Radiochemistry, John Wiley and Sons, New York.
- 2. Kaplan Traving, Nuclear Physics, Pak Publishers, Karachi.
- 3. Glasstone Samuel, Source Book on Atomic Energy, Von Nostrand, New York.
- 4. Gibbson, W.M, Nuclear Reactions, Pengiun Books Inc., New York.
- 5. Reid, J.M, The Atomic Nuclear Reactions, Pengiun Book Inc., New York.
- 6. Chopman and Rydberg, Nuclear Chemistry, Prentice Hall, New York.

PRACTICAL

Environmental Chemistry Practical

Marks:25

II. Advanced Inorganic Chemistry Labs or Research Proiect

Marks:100

- 1. Preparation and complex analysis of at least four inorganic complexes.
- 2. Chemical composition of minerals and ores, e.g., chromite, limestone.
- 3. Chemical composition of brass, solder and coin.
- 4. Chemical analysis of bentonite and cement.
- 5. Analysis of water.

III. **Instrumental methods of Chemical Analysis Practical** Marks: 100

1. **Selected calorimetric methods**

- 1.1 Determination by manganese as permanganate.
- 1.2 Simultaneous determination of binary mixtures.
- 1.3 Relative concentration error from a Ringbom plot.
- 1.4 High absorbance differential spectrophotometry.
- 1.5 Low absorbance differential spectrophotometry.
- 1.6 Photometric titrations.

2. **Potentiometric methods**

- 2.1 Acid base titrations.
- 2.2 Oxidation reduction titrations.

3. **Flame Photometry**

- 3.1 Determination of sodium and potassium
- 3.2 Determination of iron.

4. **Electrogravimetry**

- 4.1 Separation of Cu by internal electrolysis.
- 4.2 Determination of Cu in brass.

5. **Conductance methods**

- 5.1 Titration of a mixture of acids.
- 5.2 Precipitation titrations.

6. **Ion exchange and paper chromatographic method.**

BOOKS RECOMMENDED:

- 1. Wiliard, H.H., Merritt, L.K, and Dean, J.A, Instrumental methods of analysis, Van Nostrand, New York.
- 2. Kenedy, G.F, and Miller, J.M, Nuclear and Radiochemistry, John Wiley & sons, New York.
- 3. Kaplan Traving, Nuclear Physics, Pak. Publishers, Karachi.
- 4. Glasstone Samuel, Source Book on Atomic Energy, Van Nostrand, New York.
- 5. Gibson, W.M, Nuclear Reactions, Penguin Book Inc, New York.
- 6. Reid, J.M, The Atomic Nuclear Reactions, Penguin Book Inc, New York.

PESHAWAR

Syllabus:

M.Sc. (Final)

Field of Specialization:

Biochemistry

Theory

Paper No.	Title of the Paper	Marks	V Chemistry	Environmental 75
VI	Biochemistry of Macromolecule and Techniques	100		
VII	Nutrition/Physiological Chemistry	100		
VIII	Microbiology and Immunology	100		

Practicals

(i)	Environmental Chemistry practicals .	25		
(ii)	Advanced Biochemistry Chemistry	Practicals or Research Project		100
(iii)	Instrumental Methods of Analysis/= Practical	100		
Total Marks:		600		

Paper-V: ENVIRONMENTAL CHEMISTRY**Marks:75****1. Fossil fuels and energy sources**

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

2. The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulates, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemicals smog, airborne lead, control of automobile emissions.

3. Soils and mineral resources

Estimating reserves of mineral resources of earth. Extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

4. Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W, & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan, S. E, Environmental Chemistry, Brooks, California.

Paper-VI: BIOCHEMISTRY OF MACROMOLECULES AND TECHNIQUES**Marks:100****1., Enzyme Structure and functions**

Chemical nature, nomenclature and classification of enzymes. enzyme kinetics Michaelis-Menton equation. Transformation of Michaelis-Menton equation, effect of pH and temperature. Enzyme

inhibition, enzyme modification, irreversible inhibition, multisubstrate reactions, substrate specificity, functional groups essential for catalysis, factors contributing to catalytic efficiency. Some reaction mechanisms of enzyme active sites, regulatory enzymes, isozymes.

2. **Endocrinology**

Chemistry, metabolism and biological functions of pituitary gland, thyroid, parathyroids, adrenal, gonadal and pancreatic hormones; pheromones.

3. **Biochemical research techniques**

Research techniques involved in extraction, fractionation and purification of biomolecules, such as: .

- | | | | |
|-----|-------------------|-----|-------------------------|
| 3.1 | Chromatography | 3.2 | Electrophoresis |
| 3.3 | Centrifugation | 3.4 | Lyophilization |
| 3.5 | Tracer techniques | 3.6 | Electron microscopy |
| 3.7 | X-ray diffraction | 3.8 | Amino acid analyser and |
| 3.9 | Spectroscopy | | |

BOOKS RECOMMENDED:

1. Conn, E.S, and Stump, P.K, Biochemistry, John Wiley, New York.
2. Karlsson, P, Introduction to Modern Biochemistry, Academic Press, New York.
3. Yudkin, M, and Offord, Comprehensive Biochemistry, Longmann, London.
4. Cantarow, A, and Schepartz, E, Biochemistry, Saunders and Co, London.
5. Kleiner, I.S, and Orten, J.M, General Biochemistry, Mosby Co, New York.
6. Fruton, J.S, and Simmond, S, General Biochemistry, John Wiley, New York.
7. West, E.S., Todd, W., Mason, H.S., Bruggen, J.T, Textbook of Biochemistry, Macmillan, Co, New York.
8. Dowben, R, Cell Biology, Harper and Row. New York.
9. Mahler, A.R, and Cordes, E.H, Biological Chemistry, Harper and Row, New York.
10. Lehninger, A.L, Biochemistry, Worths Publications, London.
11. Bell, G.R., Davidson, J.N, and Scarborough, H, Textbook on Physiology and Biochemistry, Livingstone, London.
12. Salle, A.J, Fundamental principles of bacteriology, McGraw-Hill, New York.
13. Dawes, F.A, Quantitative problems in biochemistry. Livingstone, London.

Paper-VII: NUTRITION/PHYSIOLOGICAL CHEMISTRY

Marks: 100

1. **Nutrition**

Principles of nutrition: Chemical composition and function of nutrients energy values of foods and energy requirements. Calorimetry, RQ and BMR, balanced diet and recommended dietary allowances. Nutritional value of carbohydrates, lipids and proteins. Minerals and their requirements, functions of the major trace elements. Essential fatty acid requirements. Role of nutrition in growth. development and diseases. 2. **Physiological chemistry**

- 2.1 Functions, characteristics, general composition. Blood sugar, lipids. proteins and their functions. Haemoglobins and related substances. Mechanism of coagulation.
- 2.2 Extra-cellular fluids: Cerebrospinal fluid, synovial fluid, interstitial fluid. lymph. Sweat and tears.
- 2.3 Chemistry of respiration and gas transport.
- 2.4. Renal function, acid-base balance, electrolyte and water balance.
- 2.5 Composition and metabolism of specialized tissues.

BOOKS RECOMMENDED:

1. Conn, E.S, and Stump, P.K, Biochemistry, John Wiley, New York.
2. Karlsson, P, Introduction to Modern Biochemistry, Academic Press, New York.
3. Yudkin, M, and Offord, Comprehensive Biochemistry, Longmann, London.
4. Cantarow, A, and Schepartz, E, Biochemistry, Saunders and Co, London.
5. Kleiner, I.S, and Orten, J.M, General Biochemistry, Mosby Co, New York.
6. Fruton, J.S, and Simmond, S, General Biochemistry, John Wiley, New York.
7. West, E.S., Todd, W., Mason, H.S., Bruggen, J.T, Textbook of Biochemistry, Macmillan, Co, New York.
8. Dowben, R, Cell Biology, Harper and Row, New York.
9. Mahler, A.R, and Cordes, E.H, Biological Chemistry, Harper and Row, New York.
10. Lehninger, A.L, Biochemistry, Worths Publications, London.
11. Bell, G.R., Davidson, J.N, and Scarborough, H, Textbook on Physiology and biochemistry, Livingstone, London.
12. Salle, A.J, Fundamental Principles of Bacteriology, McGraw-Hill, New York.
13. Dawes, F.A, Quantitative Problems in Biochemistry. Livingstone, London.

Paper-VIII: MICROBIOLOGY AND IMMUNOLOGY

Marks: 100

1. Microbiology and industrial fermentation

General morphology and cytology of micro organisms. An introduction to the orders and families of microorganisms. Methods of isolation and classification. General effects of environments on microorganisms. Nutrition of microorganisms. Introduction to industrial microbiology. Growth kinetics

and oxygen transfer. Application of chemostat and turbidostat. Microbial production of alcohol, citric acid and acetic acid and their mechanisms. Antibiotic and enzyme production. Nutritional biomass.

2. **Chemotherapy and immunology**

Structure activity relationship and mode of action of antipyretics, analgesics, arsenides, antimalarials, sulpha drugs and antibiotic with special reference to penicillin. Mechanism of drug resistance. Principles of immunology, antigens antibodies, characteristics of antigen and antibody reactions. Allergy and hypersensitivity. Blood groups ABO, MNO and Rh. factor.

3. **Molecular biology (Viruses)**

Biosynthesis of RNA DNA, nucleoside polymerase, nucleoside catabolism. Types of RNA. Hybridization studies, genetic coding. Physical properties of mutagens. Eukaryotic chromosomes. Structure of chromatin and its functions. Theories of differentiation. Gene activation. Antibody production. Virus replication and its protein regulation.

BOOKS RECOMMENDED:

1. Conn, E.S, and Stump, P.K, Biochemistry, John Wiley, New York.
2. Karlison, P, Introduction to Modern Biochemistry, Academic Press, New York.
3. Yudkin, M, and Offord, Comprehensive Biochemistry, Longmann, London.
4. Cantarow, A, and Schepartz, E, Biochemistry, Saunders and Co, London.
5. Kleiner, I.S, and Orten, J.M, General Biochemistry, Mosby Co, New York.

6. Fruton, J.S, and Simmond, S, General Biochemistry, John Wiley, New York.
7. West, E.S., Todd, W., Mason, H.S., Bruggen, J.T, Textbook of Biochemistry, Macmillan, Co, New York.
8. Dowben, R, Cell Biology, Harper and Row, New York.
9. Mahler, A.R, and Cordes, E.H, Biological Chemistry, Harper and Row, New York.
10. Lehninger, A.L, Biochemistry, Worths Publications, London.
11. Bell, G.R., Davidson, J. N, and Scarborough, H, Textbook on Physiology and Biochemistry, Livingstone, London.
12. Salle, A.J, Fundamental Principles of Bacteriology, McGraw-Hill, New York.
13. Dawes, F.A, Quantitative Problems in Biochemistry, Livingstone, London.

PRACTICAL

I. Environmental Chemistry Practical Marks:25

II. Advanced Biochemistry Practical or Research Project Marks:100

1. Analysis of Urine complete.
2. Analysis of boold complete including blood groups.
3. Preprartion of different media for growing micro-organisms.
4. Sterlization techniques.
5. Growth and indentification of micro-organisms.
6. Enzymes: Study of functions and properties.
7. Biochemical preparations (2-3 preparations) i.e.,
 - 7.1 Preparation of clycogen from liver.
 - 7.2 Preparation of cytochrom-C.
 - 7.3 Preparation of RNA from beef liver.
 - 7.4 Preparation of DNA from calf spleen.
 - 7.5 Preparation of LDA.
 - 7.6 Preparation of phsophatase etc.
8. Milk & some food analysis.

Their preparation, pufication or characterization by different physico-chemical methods.

BOOKS RECOMMENDED:

1. Hawk's, Physiological Chemistry, Edi. PL Oser, McGraw Hill Publishing Inc., New York.
2. Clark Jr. J. M, and Switzer, R. L. W. H, Freeman and Co, USA.

III. Instrumental Methods of Chemical Analysis Practical Marks: 100 1 . Paper chromatography:

One dimensional and two dimensional for carbohydrates and proteins.

2. Thin Layer chromatography

Silicagel and impregnated silicagel (With AgNO₃ or borate) for lipids, fatty acids and sterols.

3. Ion-exchange chromatography

Elements, Mg, Al, etc, found in the biological fluids or foods.

4. Spectrophotometry

Use of Spectronic 20 in the determination of blood glucose, uric acid, creatinine.

5. Polarimetry

Determination of sugars in food.

6. Flame photometry

Determination of Na⁺, K⁺, present in urine/blood.

7. Electrophoresis

The determination of proteins and lipoproteins of clinical interest.

8. Potentiometry

To study the ionic properties of biological fluids.

9. Conductometry

Determination of proteins/nucleoproteins and other biological compounds.

10. Introduction to other advanced techniques i.e., NMR, mass spectroscopy, gas chromatograph, liquid HPLC etc.

BOOKS RECOMMENDED:

1. Plummer, D.I, Introduction to Practical Biochemistry, McGraw Hill, New York.
2. Wooton, L.D.P, and Churchill, A, Microanalysis in Medical Biochemistry.

INSTITUTE OF CHEMICAL SCIENCES

UNIVERSITY OF PESHAWAR

Syllabus:

M.Sc. (Final)

Field of Specialization:

Applied chemistry

Theory:

Paper No.	Title of the Paper	Marks
V	Environmental Chemistry	75
VI	Polymer Chemistry	100
VII	Metallurgy	100
VIII	Unit Operation	100

Practical

(i)	Environmental Chemistry Practicals	25
(ii)	Advanced Applied Chemistry Practicals or Research Project	100
(iii)	Instrumental Methods of Analysis Practicals	100
Total Marks:		600

1. Fossil fuels and energy sources

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy. power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

2. The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter. analysis and control of particulates, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemicals smog. airborne lead, control of automobile emissions.

3. Soils and mineral resources

Estimating reserves of mineral resources of earth. Extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

4. Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W, & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan, S. E, Environmental Chemistry, Brooks, California.

Paper-IV: POLYMER CHEMISTRY

Marks: 100

- 1 Addition polymerization, condensation polymerization, copolymerization, polymerization techniques, polymer characterization.
 - 1.1 Plastics: Celluloids, phenol formaldehyde, urea and melamine formaldehyde, polyethylene, polyvinyl acetates, polyvinyl acetal, plastics fabrication.
 - 1.2 Rubber: Natural rubber processing, vulcanization of rubber, butadiene, acrylonitrile rubber, butyl rubber, silicone rubber, neoprene rubber, thiokol rubber, polyurethane rubber. .
 - 1.3 Fibers: Viscose rayon, cuprammonium rayon, cellulose acetate rayon, nylon 66, nylon 6, acrylic and modacrylic fibers, vinyl and vinylidene fibers. .

2. Petrochemicals

Thermal cracking of ethane, propane and naphtha, catalytic and steam reforming processes, oxidation, halogenation, aromatic substitution, hydrolysis, hydration, hydrogenation, hydroformylation and esterification processes.

3. Dyes

Types of dyes, manufacture of dyes and dye intermediates, applications of dyes.

4. Explosives

Industrial and military explosives, military gases.

5. Detergents

Mechanism of detergency, types of detergents, manufacture of detergents.

BOOKS. RECOMMENDED:

1. Cowis, J.M.C, Polymer Chemistry and Physics of Modern Material, Intertext Books, 1st Ed. New York, 1973.
2. Bilimeyer, F.W, Textbook of Polymer Science, John Wiley and Sons, New York.
3. Shreve, R.N, Chemical Process Industries, McGraw Hill Book, Company, 5th Ed., New York, 1984.
4. Riegel, E.R, Industrial Chemistry, Reinhold Corporation Publishing, New York.
5. Francis, W, Fuels and Fuel Technology, 5th Ed., Pergamon Press, New York.
6. Wiseman, P, An Introduction to Industrial Organic Chemistry, 2nd Ed. Applied Science Publisghers, New York, 1979.

Paper-VII: METALLURGY

Marks: 100

1. Metallic ores, concentration of ores, metallurgy of iron, copper, aluminium, magnesium, nickel and zinc.
2. Corrosion

Direct oxidation of metals and alloys, electrochemical corrosion. Corrosion failure. Corrosion testing.

3. **Protective coatings**

Manufacture and application of paints, varnishes, lacquers enamel and metallic coatings. 4.

Ceramic and refractories

Ceramic and refractory raw materials, manufacture, properties and uses of ceramic products.

5. **Lubricants**

Mechanism of lubrication, manufacture of different types of lubricants.

BOOKS RECOMMENDED:

1. Catterll, A, Introduction to Metallurgy,
2. Bailey, A.R, A Textbook of Metallurgy, Macmillan, London.
3. Ubling, H.H, Corrosion and Corrosion Control, John Wiley and Sons, New York.
4. Evan, U. R, An introduction to Metallic Corrosion,
5. Riegal, E.R, Industrial Chemistry, Reinhold Publishing Corporation, New York.
6. Shreve, R.N. Chemical Process Industries, McGraw Hill Book Company, New York.
7. Lieghore, Chemistry of Engineering Materials, McGraw Hill Book Company, New York.

Paper-VIII: **UNIT OPERATION**

Marks:100

1. **Crushing and Grinding**

Mechanism of size reduction, Kicks law, Rittenger's Law and Bond's Law of size reduction. Particle size distribution.

2. **Evaporation**

Construction and working of different types of evaporators. Heat transfer in evaporators, methods of feeding of multiple effect evaporators. Improved efficiency in evaporators.

3. **Distillation**

Vapour liquid equilibrium, Daltons, Rault's and Henry's Law of partial pressures. relative volatility, differential distillation, equilibrium distillation and rectification. Number of plates required in a distillation column. reflux ratio and its importance in distillation.

4. **Crystallization**

Growth and properties of crystals, crystallization rate, effect of impurities of crystal formation, fractional crystallization, different types of crystalizers.

5. **Drying**

Principle of drying rate of drying, theories of drying, different types of dryers.

6. **Transportation**

Theory of filtration, flow of filtrate through cloth and cake. Types of filters, filter auxiliaries.

7. **Transportation**

Transportation of fluids and solids in industrial process.

8. **Flow of heat**

Classification of heat flow processes. Law's of heat flow.

BOOKS RECOMMENDED:

1. Coulson, J. M, and Richardson, J.F, Chemical Engineering, VolI and II, 1st Ed., Pergamon Press, New York, 1985.

2. Badger and Benchero, An Introduction to Chemical Engineering, McGraw Hill Book Co, New York 1955.

PRACTICAL

I. **Environmental Chemistry Practical** Marks:25

II. **Advanced Applied Chemistry Analysis or Research Project** Marks:100 1 Chemical examination of various vegetable & animals oils.

2 Analysis of various Pakistani ores.

3 Physical testing of cement.

- 4 Analysis of leather.
5 Analysis of milk. 6 Analysis of sugar.

III. Instrumental Methods of Analysis Practical

Marks: 1 00 1

Potentiometric titrations.

- 2 Conductometric titrations.
3 Electrogravimetric analysis.
4 Flame photometric analysis.
5 Paper chromatography, ion exchange chromatography.
6 spectrophotometric, analysis.

BOOK RECOMMENDED:

1. Vogel, A, Quantitative Inorganic Analysis, Longman, London.
2. Ewing, G.W, Instrumental Methods of Chemical Analysis, 3 Julius Grant, Chemical Analysis.
4. Mahin, Chemical Analysis.

**INSTITUTE OF CHEMICAL SCIENCES UNIVERSITY OF
PESHAWAR**

Syllabus:**M.Sc. (Final)****Field of Specialization:****Analytical Chemistry**

Theory:

Paper No.	Title of the Paper	Marks
V	Environmental Chemistry	75
VI	Elementary Analytical Chemistry	100
VII	Electroanalytical and Chromatographic Techniques	100
VIII	Spectroscopy and Electronics	100

Practical

(i)	Environmental Chemistry Practical	25
(ii)	Advanced Analytical Chemistry Practical or Research Project	100
(iii)	Instrumental Methods of Analysis Practical	100

Total Marks:**600**

1. Fossil fuels and energy sources

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy, electrochemical energy conversion, conservation of free energy, the balance of the earth.

2. The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulates, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemicals smog, airborne lead, control of automobile emissions.

3. Soils and mineral resources

Estimating reserves of mineral resources of earth. Extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, soil pH and nutrients availability.

4. Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W, & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan, S. E, Environmental Chemistry, Brooks, California.

1. Elementary Statistics

The task of statistics in chemical analysis: Theory of sampling, sources of variation and error, random error and systematic error. Presentation of results and rounding off the data.

Averages; the arithmetic mean, median, mode and geometric mean dispersion, standard deviation, mean deviation and their significance, confidence limits for the mean and standard deviations, comparison of standard deviations, inference from the tests, fitting lines to data, correlation and regression.

2. Equilibrium

The energetic and kinetic aspects of chemical equilibrium, equilibrium constants and their computation from various sources of experimental data. The effect of temperature, pressure, concentration, pH of medium and solvents on equilibrium. Conditions for selection of a method of analysis.

2.1. Ionic substances; Strong electrolytes and weak electrolytes activity, mean activity and activity coefficients.

2.2. Acids and bases and the effect of various solvents on acidity and basicity. Protic, aprotic amphiprotic and amphoteric solvents. Calculation and computation of stepwise dissociation constant from experimental data. The preparation, use and effectiveness of buffers. Techniques of pH determinations.

3. Precipitation

Solubility and solubility product. Effects of salts, solvents hydration, hydrolysis, pH changes, ageing surface exchange, adsorption etc., on precipitates. Determination of errors in gravimetric analysis. Thermogravimetric methods for testing of thermal stability.

4. DTA and TGA: Basic principles, instrumentation and applications.

5. Automation in analytical chemistry

Instrumental parameters for automated instrument, automated process and instruments in process control and clinical laboratory.

BOOKS RECOMMENDED:

1. Kolthoff, I.M, Quantitative Chemical Analysis, Macmillan, London.
2. Dick, J.G, Analytical Chemistry, McGraw Hill Book Co., New York.
3. Christian, G.D, Analytical Chemistry, John Wiley, New York.
4. Skoog, D.A, and West, D.M, Fundamental of Analytical Chemistry, Reinhold. New York.
5. Skoog, D.A, and West, D.M, Principle of Instrumental Analysis, Reinhold, New York.

6. Christian, G.D, and Reilly, J.E, Instrumental Analysis, Allyn and Bacon Inc.

Paper-VII: ELECTRO ANALYTICAL AND CHROMATOGRAPHY TECHNIQUES

Marks:100

1. Complexation

Complexation and chelate formation; competing reactions in complexation. The computation of stability constants from various experimental data. The use of complexes in analytical chemistry as reagents. Masking agents. Indicators and metal ion buffers. Complexometric titrations.

2. Electrode phenomenon

The electrochemical cell. Oxidation and reductions potentiometric methods. various types of electrodes and their use, over potentials membrane potentials. Some well known redox reactions of analytical importance, ion selective electrodes, direct potentiometric measurement, potentiometric titration.

3. Chromatography

Adsorption and distribution laws as applied to chromatography. The displacement,, frontal method of analysis and elution techniques.

3.1. Column paper and thin-layer chromatography, suitable systems for analysis of some simple organic substances. Reversed phase chromatography, high pressure liquid chromatography.

3.2. Gas chromatography; GSC and GLC parameters governing gas phase separations, simple instrumentation for gas chromatography. Suitable systems for analysis, high temperature programmed analysis.

3.3. Electrophoresis; Paper electrophoresis, constant current and constant potential paper electrophoresis.

4. Principal of polarography

Principal of polarography, instrumentation, different modes of polarography. Application of the inorganic and organic analysis. Principles of stripping voltammetry type of stripping voltammetry and application analysis of cations and anions.

40

5. Radiochemical methods

Neutron activation analysis, isotopic dilution method, radiometric methods and applications.

BOOKS RECOMMENDED:

1. Skooge, D.A, and West, D.M, Principle Analysis, GcGraw Hill Book Co, New York.
2. Braun, R.D, Introduction to Chemical Analysis, McGraw Hill Book Co., New York. 3.
Christian, G.D, and Reilly, J.E, Instrumental Analysis, Allyn and Bacon Inc., New York.

Paper-VIII: SPECTROSCOPY AND ELECTRONICS

Marks: 100

1. UV/VIS SPECTROSCOPY

i) Introduction to spectroscopy

Electromagnetic radiations & different Spectral Regions

Types of Spectra

Types of interaction of Electromagnetic radiations with matter

Types of Electrons in a molecule

Types of Electronic Transitions

Transition Rules

Concept of Chromophore & Auxochrome

Types of Spectral changes

Effect of structure on absorption of Radiation by a molecule Absorption by Organic and Inorganic Compounds

Beer's Law & Deviations from Beer's Law

Determination of relationship between absorbance and concentration / Calibration methods

Quantitative Analysis ,Scope of UV/VIS spectroscopy Applications of UV/VIS spectrophotometry:

- a) *Determination of Formula & Stability Constant of a Complex*
- b) *Determination of pK_{ind} of an Indicator*
- c) *Mixture Analysis*
- d) *Photometric Titration*
- e) *Automated photometric & Spectrophotometric Methods*

ii) Instrumentation

Overview of Instrument components

Spectroscopic Sources, continuous and line sources

Monochromators

Sample containers

Detectors

Signal Processor and Readout Device

Types of Instrument Design i.e Colorimeter, Photometers, Spectrophotometers

Types of Instruments:

- a) *Single beam instrument*, b) *Double beam instrument*
- c) *Multichannel instruments*

2. MOLECULAR FLUORESCENCE & PHOSPHORESCENCE SPECTROSCOPY

Introduction & Instrumentation

Luminescence & types (Bioluminescence, Electroluminescence, Photoluminescence)

Principles of Photoluminescence

Difference between Fluorescence & Phosphorescence

Factors affecting Fluorescence

Quantum efficiency

Instrumentation

Photoluminescent spectra

Advantages and Disadvantages of Fluorescence & Phosphorescence Phosphorimetry

Photoluminescence Analysis

Qualitative & Quantitative Applications

3. ATOMIC SPECTROSCOPY

i) Atomic Absorption Spectroscopy

History, Basic Principle,

Instrumentation a) Light Source b) Atomizer i.e Flame Atomizer & Electrothermal Atomizer, Monochromator, Detector, Amplifier & Readout

Factors affecting Atomization, Interferences in AAS

Advantages & Disadvantages of AAS

Analytical Applications

ii) Atomic Fluorescence Spectroscopy

Introduction, History

The Fluorescence Process, Types of Fluorescence

Instrumentation: Light Source (Lasers), Atomizer (Flame & Plasma), Monochromator

Detector, Amplifier & Readout

Interferences in AF

Analytical Applications

iii) Atomic Emission spectroscopy

a) FLAME PHOTOMETRY

Basic principle, Instrumentation, Interferences, Advantages & Disadvantages, Applications of Flame Photometry

b) EMISSION SPECTROGRAPHY

Introduction, History,

Instrumentation a) Excitation Sources i.e arc & spark b) Sample holders
Instrument types a) spectrographs b) polychromators
Advantages & Disadvantages
Qualitative & Quantitative applications General Applications

4. MASS SPECTROMETRY

Introduction & Instrumentation

History, Basic principle

Instrumentation & Principle of Operation

(a) Sample input system b) Ionization source, c) Mass analyzer d) Detectors

Applications

Application of Mass Spectrometry

5. NMR

Introduction & History, Principle of NMR, Instrumentation , Chemical Shift & Spin Spin Coupling, spectra interpretation

6. B-ELECTRONICS

1. Electricity

The Characteristics of ac & dc, Series & Parallel circuits involving resistors, inductors & capacitor currents , Voltage , Current & Resistance measuring devices

2. Electron Tube

Introduction to Diodes, Triodes , Tetrode , Pentode vacuum tubes

Characteristic curves for these tubes

Simple circuits involving Rectification, Amplification, Power stabilization

Special electron tubes i.e

Cathode ray tube, Phototube, gas filled tubes

Ordinary uses of these tubes

3. Thermistors & Transistors

Introduction to Thermistors & Transistors Uses of Thermistors

& Transistors

BOOKS RECOMMENDED:

1. Christian, G.D, and Reilly, J.E, Instrumental Analysis, Allyn and Bacon Inc., New York.
2. Braun, R.D, Introduction to Instrumental Analysis, McGraw Hill Book Co, London.
3. Bernhard Wetz, Atomic Absorption Spectroscopy, Verlay Chemie, New York.
4. Willard, Meritte and Dean, Instrumental Analysis, DVan Nostrand, New York.

5. Thompson, K.C, and Reynold, R.J, Basic Electronics, Charles Griffin and Co. London.
6. Marcus, A, and Gendler, Basic Electronics, Engle Wood Printice Hall.

PRACTICAL

I. Environmental Chemistry Practical Marks:25

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of chloride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.
6. Determination of primary aromatic amines in spectrophotometric method. 7. Determination of ammonia in water sample by spectrophotometric method.
8. Determination of alkalinity of water sample.
9. Determination of hardness of water sample.
10. Determination of nitrate and nitrite in water sample.

II. Advanced Analytical Chemistry Practicals or Research Project Marks: 1 00

1. Simultaneous determination of Cr^{+++} and Mn^{++} in a given solution.
2. Determination of Cr(VI) in the presence of Cr(III) by spectrophotometric method.
3. Preconcentration, solvent extraction and determination of heavy metals by available methods.
4. Determination of vitamin C in the given sample by available method.
5. Analysis and quantification of various pharmaceutical samples.
6. Determination of acid content in soda water by potentiometric titration.
7. Conductometric titration of mixture of acids.
8. Determination of Fe and Mn in soil by spectrophotometric method.
9. Ion exchange separation of selected cations and anions.
11. Separation of the given mixture of amino acids by TLC. 12. Determination of the ammonia in ammonium chloride salt by back titration.

III. Instrumental Method of Analysis Practical Marks: 100

1. Determination of aniline in a given sample by double beam uv-visible spectrophotometer.
2. Determination of tannin in tea leaves by spectrophotometric method.
3. Determination of stepwise ionization constant of H_3PO_4 .
4. Determination of salicylic acid by conductometric titration.
5. Determination of the formula and stability constants by spectrophotometric method.
6. Determination of heavy metals in the given sample by Atomic Absorption Spectrophotometric method.
7. Determination of sulphanimide in the given drug sample by spectrophotometric method.
8. Determination of P_ka value of an indicator by spectrophotometric method.
9. Determination of sodium and potassium in the given sample by flame photometry.
10. Determination of nicotinic acid in cigarette smoke by HPLC using reverse phase chromatography.
11. Separation of aromatic hydrocarbons by gas chromatography using FID. 12. Effect of concentration on the fluorescence intensity of fluorescence.

**INSTITUTE OF CHEMICAL SCIENCES UNIVERSITY OF
PESHAWAR**

Syllabus: **M.Sc. (Final)**
Field of Specialization: **Fuel Chemistry**

Theory:

Paper No.	Title of the Paper	Marks
V	Environmental Chemistry	75
VI	Chemistry of Coal Conversion Processes	100
VII	Petroleum and Petrochemicals	100
VIII	Characterization of Fossil Fuels by Advanced Instrumental Techniques	100
Practical		
(i)	Environmental Chemistry Practical	25
(ii)	Advanced Fuel Chemistry Practical or Research Project	100
(iii)	Instrumental Methods of Analysis Practical	100
Total Marks:		600

46 **Paper-V: ENVIRONMENTAL CHEMISTRY** Marks:75

1. **Fossil fuels and energy sources**

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H-economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

2. **The atmosphere and air pollution**

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulates, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen and photochemicals smog, airborne lead, control of automobile emissions.

3. **Soils and mineral resources**

Estimating reserves of mineral resources of earth. Extraction of metals-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, soil pH and nutrients availability.

4. **Water and water treatment**

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of micro organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

5. **The green revolution**

Pest control, pesticides, toxicity of pesticides, pest management.

BOOKS RECOMMENDED:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. Moore, J.W, & Moore, E.A, Environmental Chemistry, Academic Press, New York.
3. Banerji, S.K, Environmental Chemistry, Prentice Hall, Delhi.
4. Banerji, S.K, Environmental Chemistry, Tata Publisher, Delhi.
5. Manahan, S. E, Environmental Chemistry, Brooks, California.

1. Combustion of coal

Burning systems for coal combustion, combustion furnaces and boilers, grate firing, fluid bed firing and entrained firing systems, heat rates and firing densities, coal behaviour in combustion systems, propagation and stabilization of coal flames, combustion products analysis, pollution problems in coal combustion and their control.

2. Gasification of coal

General gasification principles, equilibrium, thermodynamics, kinetics and catalytic aspects of coal gasification, fixed bed gasifier, fluidized bed gasifier, transport reactor, liquid medium gasifier and underground gasification, gas upgrading by carbon monoxide shift, gas purification, methanation and dehydration, properties and processing of gaseous fuels, environmental consideration, economic and perspectives.

3. Liquefaction of coal

Historical developments of coal liquefaction, solvent extraction of coal, direct liquefaction of coal through catalytic hydrogenation, indirect liquefaction of coal through Fischer-Tropsch synthesis. Effects of coal properties, catalyst and solvent on liquefaction behaviour of coal. Purification of liquefaction products. Description of high pressure coal liquefaction reactors and auxiliary devices, environmental consideration, economics and perspective of coal liquefaction processes.

BOOKS RECOMMENDED:

1. Wen, C.Y, and Stanley, S, Coal Conversion Technology, Addison-Wesley, New York.
2. Probst, R.F, and Hicks, R.E, Synthetic Fuels, McGraw Hill, New York.
3. Francis, W, Fuels and Fuel Technology, Pergamon Press, London.
4. Merick, D, Coal Combustion and Conversion Technology, Macmillan Ltd., London.

1. Cracking and reforming of petroleum fractions

Preparation, structure and properties of cracking and reforming catalysts. Mechanism and kinetics of cracking and reforming. Effect of operating conditions on cracking and reforming products. Construction and operation of thermal, and catalytic cracking and reforming units. Hydroforming and desulphurization of petroleum products.

2. Petrochemicals

Petrochemicals from cracking, reforming, oxidation, halogenation, hydrogenation and aromatic substitution of hydrocarbons.

3. Thermochemistry and combustion of hydrocarbon fuels

Basic thermodynamics principles, standard enthalpy of formation, standard enthalpy of reaction, enthalpy of combustion products. Mechanism of combustion of gaseous and liquid hydrocarbon, fuel combustion equilibrium, equilibrium product composition in fuel air combustion, equilibrium temperature in adiabatic combustion, theory of flame propagation, method of measuring flame speed, fuel performances in reciprocating piston engines and continuous combustors, environmental pollution from hydrocarbon fuel utilization.

4. Storage and handling of hydrocarbon fuels

Storage, transportation, and handling of hydrocarbon fuels, volatility losses, fire hazards and prevention. Extinguishing of oil fires methods.

BOOKS RECOMMENDED:

1. Hobson, G.D, Modern Petroleum Technology, Part 2, John Wiley and Sons, New York.
2. Gates, B. C, Katzer, J. R, and Schuit, G.C.A, Chemistry of Catalytic Processes, McGraw Hill Book Company, London
3. List, H.L, Petrochemical Technology, Printice-Hall Englewood Cliffs, New Jersey.
4. Marion L. Smith, Karl W.Stinson, Fuels and Combustion, McGraw Hill Book Company.
5. Goodger, E.M, Hydrocarbon Fuels, Union Brothers Ltd, London.
6. Maleev, V.L, Internal Combustion Engines, McGraw Hill Book Company London, 1973.
7. Hughes, J.R, and Swindells, N.S, Storage and Handling of Petroleum Liquids, Charless Griffin and Company Ltd, London.

Paper-VIII: CHARACTERIZATION OF FOSSIL FUELS BY ADVANCED INSTRUMENTAL TECHNIQUES

Marks: 100

1. UV-Visible Spectroscopy

General theory and principals, spectral regions, molecular spectra, Beer's Lambert law and its deviations, electronic transitions, selection rules, chromophore concept.

Instrumentation: Light sources, monochrometers, detectors, single and double beam spectrophotometer.

General applications and applications for characterization of fossil fuels.

2. Infra-red spectroscopy

General theory and principles: molecular vibrations, selection rules.

Instrumentation: Optical materials and detectors, infrared spectrophotometer.

General applications and applications for characterization of fossil fuels.

3. Atomic absorption

General principles, atomic spectra.

Instrumentation: Atomization, sources of radiation, atomic absorption spectrophotometer, background correction. Applications for characterisation of fossil fuels.

4. Nuclear magnetic resonance spectroscopy

General theory and principles: The spinning nucleus, precessional frequency, nuclear and spin-lattice relaxation, the chemical shift, spin-spin splitting.

Instrumentation: the NMR spectrometer. Application for characterization of fossil fuels. Electron spin resonance; resonance condition, hyperfin splitting, ESR instrument. Application of ESR for characterization of fossil fuel.

5. Mass Spectrometry

Basic principles.

Instrumentation: Vaporization systems, sources, single and double focusing spectrometers, interpretation of mass spectrum, phenomenon of fragmentation. Application for characterization of fossil fuel.

6. X-ray fluorescence and diffraction

General theory and principles; X-ray, x-ray fluorescence, Bragg's law, x-ray diffraction.

Instrumentation: X-ray generation, x-ray fluorescence spectrometers, radioactive sources, preparation of sample for x-ray fluorescence analysis, interpretation of x-ray fluorescence spectra, diffraction apparatus. Application of x-ray fluorescence and diffraction for characterization of fossil fuels.

7. Chromatography

General theory and principles; classification of chromatographic separations, Elution chromatography, theory of elution chromatography, retention time, capacity factor, resolution of column, types of liquid chromatography. Combination of chromatography with mass spectrometry.

Instrumentation: gas chromatograph, HPLC columns, detectors. application of chromatography for characterization of fossil fuels.

BOOKS RECOMMENDED:

1. Ewing, G.W, Instrumental Methods of Chemical Analysis, McGraw Hill, London.
2. Clarence Karr Jr., Analytical Methods for Coal and Coal Products, Academic Press, New York.
3. Kagler, S.H. John Wiley and Sons, New York.
4. Christion, G.D, Instrumental Analysis, Allyn and Bacon, Inc, Boston, London.

PRACTICAL

Marks:25

I. Environmental Chemistry Practical

II. Advanced Fuel Chemistry Practicals or Research Project

Marks: 100

1. Determination of true reactivity of coke.
2. Determination of ash in petroleum products.
3. Determination of calcium and barium in lube-oil.
4. Determination of the acidity and alkalinity of greases.
5. Determination of mercaptan sulphure in motor fuels, kerosine, and similar petroleum products.
6. Determination of total solids in used engine oils.
7. Determination of total sediments in residual fuel oils.
8. Determination of total sulphur in coal and coke by Escka method.
9. Determination of chlorine in coal by Escka method.

BOOKS RECOMMENDED:

1. Clarence Karr Jr., Analytical Methods for Coal and Coal Products, 1st Ed. Academic Press, 1978.
2. Methods for Analysis and Testing, IP Standard for Petroleum and its Products, Part-I and Part II, 39th Ed., Heyden and Sons, 1980.

III. Instrumental Methods of Chemical Analysis Practical

Marks: 100

1. Determination of the electrical conductivity of aviation and distillate fuels, containing a static dissipator additives.
2. Determination of the total base number of petroleum products by potentiometric titration.
3. Determination of total salt content in crude petroleum by conductivity method.
4. Determination of the kinematic viscosity of asphalt (bitumen).
5. Determination of heat of combustion of liquid hydrocarbon fuels.
6. Determination of neutralization number by potentiometric titration.
7. Determination of the calorific value of coal by bomb calorimeter.
8. Determination of total sulfur in coal by bomb calorimeter.
9. Determination of chlorine in coal by bomb calorimeter.
10. Determination of the distillation behaviour of petroleum fractions.
11. Determination of sulfur in petroleum products by bomb calorimeter method.
12. Determination of sulfur in petroleum products by lamp method.

BOOKS RECOMMENDED:

1. Clarence Karr Jr., Analytical Methods for Coal and Coal Products, 1st Ed. Academic Press, New York.
2. Methods for Analysis and Testing, IP Standard for Petroleum and its Products, Part-I and Part-II, 39th Ed., Heyden and Son, New York.