

SYLLABUS
M.Sc. Annual System
For Affiliated Colleges
Subject: (Chemistry)
(2 Years)



DEPARTMENT OF CHEMISTRY
UNIVERSITY OF MALAKAND
CHAKDARA, DIR (L.)
2009

DETAILED BREAKUP

S#	Course with duration	Marks		
		Theory	Practical	Total
1	M.Sc (Previous) (one year)	400	200	600
2	M.Sc (Final) (one year)	400	200	600
Category Total		800	400	1200

M.Sc. Previous

(First Year)

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

THEORY

<u>Paper No.</u>	<u>Title of the Paper</u>	<u>Marks</u>
Paper-I	<i>Maths and Physical Chemistry</i>	100 Marks
Paper-II	<i>Organic Chemistry</i>	100 Marks
Paper-III	<i>Inorganic Chemistry</i>	100 Marks
Paper-IV	<i>Analytical Chemistry/Biochemistry/ Applied Chemistry</i>	100 Marks

PRACTICALS

<u>Practical No.</u>	<u>Title of the Practical</u>	<u>Marks</u>
Practical-I	<i>Physical Chemistry</i>	50 Marks
Practical-II	<i>Organic Chemistry</i>	50 Marks
Practical-III	<i>Inorganic Chemistry</i>	50 Marks
Practical-IV	<i>Analytical Chemistry/Biochemistry/ Applied Chemistry</i>	50 Marks
Total Marks		600 Marks

Paper-I: MATHEMATICS FOR CHEMISTS/PHYSICAL CHEMISTRY

Marks: 100

Maths: 25 Marks

Physical Chemistry: 75 Marks

Theory

MATHEMATICS FOR CHEMISTS:

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 differentiations, 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, solution of the problems of integral calculus found in physical chemistry text book.
8. Infinite series, Maclaurin series, Taylor series, Fourier series.

PHYSICAL CHEMISTRY

1. The Kinetic Molecular Theory of Gases

The kinetic molecular gas model, the pressure of a gas, kinetic energies and temperature, numerical values for molecular energies and molecular speeds, Maxwell-Boltzmann law distribution of molecular velocities in one dimension and three dimensions, the mean free path, collision diameter and collision numbers, viscosity, theory of non-ideal behavior, Vander Wall's equation and the critical point law of corresponding state.

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 energy due to translational motion of a

mole of gas, thermal energy due to rotational motion of the molecules of a gas, thermal energies due to vibration motion of molecules.

3. **Atomic Structure:**

Nature of light, atomic spectra, the wave nature of particle, 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 law 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. **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 reaction of gas-phase, free-radical intermediates, reaction mechanisms and rate laws, the stationary state method.

6. **Surface Chemistry:**

Adsorption in general, components of adsorption-adsorbate and adsorbent, types of adsorbate and adsorbents, types of adsorption, Adsorption kinetics, applications of adsorption of kinetics in physical chemistry, derivation of thermodynamic parameters from adsorption kinetics, Adsorption isotherm in general, Freundlich's and Langmuir's adsorption isotherms-derivations and applications, mechanism of adsorption, Factors affecting adsorption, Heterogeneous catalysis.

7. **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 coefficient and their uses.

RECOMMENDED BOOKS (THEORY)

1. Alberty, R. A., Robert J.S. and Mounqi G. B. "Physical Chemistry". 4th ed. John Wiley and Sons (2004).
2. Aston J.G. and Fritz J.J. "Thermodynamics and Statistical Thermodynamics" John-Wiley, New York (1987).
3. Atkins, P.W. "Physical Chemistry" 6th ed., W.H. Freeman and Co. New York (1998).
4. Bansal, R.C.; Donnet, J. B.; Stoeckli, F.; *Active Carbon*, Marcel Decker, New York, 1988.
5. Barrow G.M. "Physical Chemistry" 5th ed., McGraw Hill (1992).
6. Berry R. S., Stuart A.R., and Roses J. "Physical and Chemical Kinetics" 2nd ed., Oxford University Press (2000).
7. Bockris J.O.M. and Reddy A.K.N. "Modern Electrochemistry" Vol-I and II, 4th ed. Plenum Press, London (2003).
8. Brain S.E. "Basic Chemical Thermodynamics" 4th ed., E.L.B.S. Publishers (1990).
9. Chorkendorff, I. and Niemantsverdriet, J.W. "Concept of Modern Catalysis and Kinetics" 1st ed., John Wiley and Sons (2003).
10. Engel, Thomas and Reid p., "Thermodynamics, Statistical Thermodynamics, and Kinetics" 1st ed., Benjamin Cummings (2006).
11. Espenson, J. H. "Chemical Kinetics and Reaction Mechanism" 2nd ed., McGraw Hill (2002).
12. Frost A.A. and Pearson R.G. "Kinetic and Mechanism" 2nd ed. John Wiley and Sons Inc, New York (1961).
13. Gasser R.P.H. and Richards W.G. "Entropy and Energy Levels" Oxford University Press (1974).
14. Graybal J.D. "Molecular Spectroscopy", New York, McGraw-Hill (1988).
15. Griffiths, David J., "Introduction to Quantum Mechanics" 2nd ed. Prentice Hall (2004).
16. Hayward, David O. "Quantum Mechanics for Chemists" 1st ed. John Wiley (2003).

17. House, James E., "Fundamentals of Quantum Mechanics" 2nd ed., Elsevier-Academic Press (2003).
18. Laidler K.J. "Chemical Kinetics" 3rd ed. Pearson Education Company, New York (1987).
19. Laidler, K. L. "Chemical kinetics", McGraw-Hill, New York.
20. Micheal D.F. "Elements of Quantum Mechanics" Oxford University Press (2005).
21. Peter P.A. "Chemical Thermodynamics" Oxford University Press (1983).
22. Ravue, "Principles of Polymer Chemistry" 2nd ed. Plenum Publishers (2000).
23. Smith, E. Brain, "Basic Chemical Thermodynamics" 5th ed., Imperial College Press (2004).
24. Wayatt P.A.H. "The Molecular Basis of Entropy and Chemical Equilibrium" Royal Institute of Chemistry London (1971).
25. Whiffen D. H. "Spectroscopy" Longmans Green and Co.: London, (1966).

Practicals-I

PHYSICAL CHEMISTRY

Marks: 50

1. Determination of specific rate constant and activation energies for 1st order and 2nd order reactions.
2. Evaluation of thermodynamic quantities;
 - (i) Entropy (ii) Heat contents by calorimetric method.
3. Refractometry
4. Molecular weight determination by cryoscopic method.
5. Molecular weight determination by ebullioscopic method.
6. Conductance measurement.
7. Conductometric titration.
8. Buffer solution and pH measurement.
9. Measurement of standard emf of a cell.
10. Determination of equilibrium constant from emf measurement.
11. Molecular weight determination of high polymers.
12. Potentiometric titration.
13. Colorimetry.

RECOMMENDED BOOKS (PRACTICALS)

1. Bassette J., Denney C., Jeffery G. H. and Mendham J. "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society. 4th ed. (1978).
2. Daniel, F., "Experimental Physical Chemistry" McGraw Hill (1962).
3. David P. "Experiments in Physical Chemistry" 5th ed. (1989).
4. Helpen Arthur M., "Experimental Physical Chemistry: A Laboratory Textbook" 2nd ed., Prentice Hall (1997).
5. Jaffar M. "Experimental Physical Chemistry" University Grants Commission (1989).
6. James A.M. and Prichard F.E. "Practical Physical Chemistry" 3rd ed. Longman (1974).
7. Shoemaker D. "Experiments in Physical Chemistry" 5th ed., McGraw Hill Publishing Company Limited (1989).
8. Shoemaker D.P., Garland C.W. and Nibler J.W. "Experiments in Physical Chemistry" McGraw Hills, New York (1989).

Paper-1I:

ORGANIC CHEMISTRY

Marks: 100

THEORY

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. HPLC (basic introduction), counter current chromatography
3. **Chemical Bonding in Organic Chemistry:**
Localized chemical bonding VSEPR theory, VBT, de-localized chemical bonding MOT, inductive effect aromaticity, resonance, hyper-conjugation, tautomerism.
4. **Stereochemistry:**
Optical isomerism and optical activity, geometrical isomerism, conformational analysis. Homo topic heterotopic legends Legends, pro chiral centers, re faces si faces
5. **Organic Acid and Bases:**
6. **Organic Reaction Mechanisms:**
Mechanisms and methods of determining them, effect of structure on reactivity, aliphatic nucleophilic substitution, aromatic electrophilic substitution, elimination reactions. Free radical mechanism electrophilic and nucleophilic addition.
Metathesis reaction mechanism with special reference to olefine metathesis
7. **An Elementary Introduction to Spectral Method of Analysis.**
I.R, U.V, N.M.R and Mass spectrometry.

Practicals-II

ORGANIC CHEMISTRY

Marks: 50

1. **Laboratory Basic Techniques:**
Determination of boiling points of organic liquids by simple distillation, determination of melting points of organic compounds, recrystallization of the crude organic compounds.
2. **Organic Synthesis:**
 - Synthesis of nitrobenzene from benzene and nitration mixture.
 - Synthesis of dinitrobenzene from nitrobenzene (using the previous step).

- Synthesis of benzoin from benzaldehyde (Benzoin condensation).
- Synthesis of benzol from the crude benzoin (using the previous step).
- Synthesis of benzoic acid from benzoin (using the previous step).

3. **Chromatographic Techniques:**

- Separation of ink by ascending paper chromatography.
- Separation of ink pigments by ascending paper chromatography.
- Separation of amino acids by ascending paper chromatography.
- Separation of amino acids by descending paper chromatography.
- Separation of amino acids by T.L.C.

4. **Organic Compounds Analysis**

To analyze the organic compounds (Analysis of at least three known and three unknown compounds)

RECOMMENDED BOOKS

1. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
2. Atta-ur-Rehman, "Nuclear Magnetic Resonance Spectroscopy", UGC, Islamabad.
3. Bailey Jr., P. S. and Bailey, C. A., "Organic Chemistry-A Brief Survey of Concepts and Applications", Prentice-Hall, New Jersey.
4. Bansal, R. K., "Organic Reaction Mechanisms", Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Braithwaite A., and F. Y Smith, "Chromatographic Methods", Chapman & London, (1985).
6. Bruckner, R., "Advanced Organic Chemistry-Reaction Mechanisms", Harcourt Science & Technology Company, New York.
7. Carey, F. A. and Sundberg, R. J. "Advanced Organic Chemistry Part B: Reactions and Synthesis", Plenum Press, New York.
8. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.
9. Silverstein, R. N., Bassler, G. C. and Morrill, T. C., "Spectrometric Identification of Organic Compounds", John Wiley & Sons, New York.

10. Streitwieser Jr., A. and Heathcock, C.H., "Introduction to Organic Chemistry", Macmillan Publishing Company, New York.
11. Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
12. Vishnoi, N. K., "Advanced Practical Organic Chemistry", Vikas Publishing House Pvt. Ltd., New Delhi.
13. Vogel, A. I., "Elementary Practical Organic Chemistry Part 3:Quantitative Organic Analysis", Longman, London.
14. Wade Jr., L. J., "Organic Chemistry", Pearson Education, Delhi.
15. Williams D. H. and Fleming, I., "Spectroscopic Methods in Organic Chemistry", Athlone Press, London.

Theory

1. Electron 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 Terms symbols, Terms symbols and their applications to the interpretation of spectra.

2. Coordination Compounds:

Applications of various theories of chemical bonding to coordination compounds (VBT, CFT, MOT), thermodynamics, kinetics, magnetic and spectral properties.

3. Acceptor Complexes:

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

4. Electron Transfer Processes:

a) Acids and bases, soft and hard acid and base concept, detailed treatment and applications in chemistry, acid base catalysis, heterogeneous and homogeneous 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 reaction of solvents, effect of physical and chemical properties of solvents, pH treatments in non-aqueous media, chelation in non-aqueous media, detailed study of liquid ammonia, liquid SO₂, and liquid HF.

6. Chemistry of f-Block Elements:

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

(b) Actinides, electronic structure and position in the periodic table, general characteristics, nuclear reactions.

Practicals-III**INORGANIC CHEMISTRY****Marks: 50**

1. Semimicro qualitative analysis of an inorganic mixture containing 6 radicals including interfering and insolubles.
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^{2+} and Al^{3+}
 - iii) Cu^{2+} and Ni^{2+}
 - i) Cu^{2+} and Zn^{2+}
4. Separation of cations by ion exchange chromatography.

RECOMMEDED BOOKS

1. Clyde Day, M. & Selbin, J., "Theoretical Inorganic Chemistry", 2nd Ed., Van Nostrand Reinhold, 1969.
2. Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2nd Edition, 1994.
3. Bassette, J., Denney, G. H. and Mendham, J., "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4th Edition, 1981.
4. Vogel, A. I., "A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis" Longman Green & Co. 1995.
5. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
6. Atkins, P. and Jones, L., "Chemicals Principles" Freeman & Company, 2002.
7. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, "Advanced Inorganic Chemistry", 6th Ed., Wiley-Interscience, New York, 1999.
8. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann. M., "Advanced Inorganic Chemistry", 6th Ed., Wiley-Interscience, New York, 1999.
9. Harvey, B.G. "Nuclear Physics and Chemistry", Prentice-Hall Inc., 1990.

Paper IV:

ANALYTICAL CHEMISTRY

Marks: 100

Theory

1. Fundamental Concepts of Analytical Chemistry:

Solutions preparation, electrolytes, chemical units, stoichiometric relationships

2. Theory of Errors:

Accuracy, precision and their presentation, error and 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 Hasselbalch equation, activity coefficients and its calculation, hydrolysis of salts and pH calculations,

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 theory of Indicators

6. Theory of Volumetric analysis:

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

7. Absorption Spectroscopy:

Bea-Lambert;s Law, applications and its limitations, IR, UV and Visible spectroscopy,

8. Electrometric Methods:

Polarography, conductometry, potentiometry, amperometry, coulometry and electrogravimetry

9. Sampling:

Practicals-IV:

ANALYTICAL CHEMISTRY

Marks: 50

1. Acid base titrations

2. Redox titrations

3. Complexometric titrations
4. Precipitation titration
5. Potentiometric titrations
6. Conductometric titrations
7. Verification of Beer Lambert Law (absorption spectroscopy)
8. Flame photometry of alkali and alkaline metals
9. Column and paper chromatography
10. Ion exchange separation of metal ions in simple systems

Other experiments will be based on the available facilities

RECOMMENDED BOOKS

1. Analytical Chemistry by Gary D. Christian; 6th ed. 2004; John Wiley & Sons, Inc.
2. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, "Fundamentals of Analytical Chemistry" 8th ed. 2003; Saunders College Publishing, Philadelphia.
3. Instrumental Methods of Analysis by Hobert H. Willard D.L. Merritt & J.R.J.A. Dean, Frank A. Settle; 7th Sub edition 1988; Wadsworth Publishing Company.
4. Laboratory Manual of Analytical Chemistry by C. Reilly; Allyn and Bacon, London.
5. Quantitative Analysis by W. J. Blaedal and V. W. Medloche; Harper & Row, N.Y.
6. J.G. Dick, Analytical Chemistry, McGraw-Hill, Tokyo.

Paper-IV:

APPLIED CHEMISTRY

Marks: 100

Theory

1. Unit operations:

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, oil, and soap industries

7. Leather industries

8. Fermentation industries

9. Fertilizer industries

10. Cement and glass industries

Practicals-IV:

APPLIED CHEMISTRY

Marks: 50

Chemical examination of

- Water
- Fertilizer
- Brass
- Bronz
- Steel
- Cement
- Soap
- Coal

RECOMMENDED BOOKS

1. Badger L.W. and T.J. Banchero. (1955) "Introduction to Chemical Engineering" Student ed. McGraw-Hill Book Company, New York.
2. Riegel, E.R. (1956)." Industrial Chemistry" 5th ed. Reinhold Publishing Corporation, New York.
3. R. N. Shreve, The chemical process industries, McGraw-Hill Book Company.
4. Vogel, I. A.,Text Book Quantitative Inorganic Analysis, 7rd Ed., Longman, Green and Co. Ltd. UK (1961) and (1978).
5. E D Mahin, Chemical analysis McGraw-Hill Book Company, New York.
6. G.H.Jenkins, Intoduction to Sugarcane Technology (1965).
7. Howard L. White, Introduction to Industrial Chemistry (1992).
8. P. F. Stanbury & A. Whitaker, Principles of fermentation Technology, (1987).
9. G. C. Bye., Portland Cement, (1983).
10. We Worrall, Clays, (1968).
11. Academy of Science USSR, The Structure of glass, (1953).
12. G. O. Jones, Glass, 2nd Ed., (1971).

Paper-IV:

BIOCHEMISTRY

Marks: 100

Theory

Introductory Biochemistry:

1. 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. **Metabolism:**
 - i). Carbohydrates; transport of sugars into cells, glycolysis, HMP pathway and its significance, citric acid cycle. Gluconeogenesis. Photosynthesis.
 - ii). Lipids; knops oxidation theory, fatty acid catabolism, biosynthesis of triglycerides, phospholipids, sterols and bile acids, formation and metabolism of ketones bodies.
 - iii). Proteins and amino acids; decarboxlyaton, transamination, and deamination reactions, urea cycle, creatine and uric acid synthesis, biosynthesis of proteins, inter relationship between carbohydrates, lipids and protein metabolism.

Practicals-IV:

BIOCHEMISTRY

Marks: 50

1. Study of cell structure under light microscope.
2. Qualitative test for carbohydrates; distinction between pentoses and hexoses, aldohexoses and ketohexoses, reducing and non-reducing sugar 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. Test for fats, sterols and phosphorlipids, 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.

RECOMMENDED BOOKS

1. Lehninger, A. L., "Principles of Biochemistry", Worth Publisher, New York, (2001).
2. Voet, D. and Voet J. G., "Biochemistry", John Wiley & Sons, New York, (2000).
3. Murray, R. K., Mayes P. A., Granner, D. K. and Rodwell, V. W., Harper's Biochemistry", Appleton & Lange (2000).
4. Robert, Harper's Biochemistry", 25th Ed, (2000).
5. West, Text Book of Biochemistry", 4th Ed., (2000).
6. Zubay, G., Biochemistry, 4th Ed., Macmillan Publishing Co. (1999).
7. Bhagavan. N. V., Biochemistry, 2nd Ed., J.B. Lippincott Company (1978)
8. Smith, E.L., R.L. Hill, I.R. Lehman, R.J. Lefkowitz, P. Handler, and A. White. Principles of Biochemsitry (Mammalian Biochemistry) McGraw-Hill Companies Inc.
9. Gowenlock, A. H., Varley's Practical Clinical Biochemistry, 6th Ed., Heinemann Professional Publishing, Oxford (1988).
10. Sawhney, S. K. and R. Sing (Editors), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, (2005).
11. Gosling, J. P., Immunoassay: Laboratory Analysis and Clinical application (1994).

M.Sc. Final

(Second Year)

For each specialization, there shall be four theory papers. One paper (Paper-V, Environmental Chemistry, Marks: 75) is compulsory for each specialization. The rest of the three papers each of 100 marks will be from specialization. There shall be three practical papers, one for the Environmental Chemistry (Marks: 25) and two from specialization each of 100 marks.

Field of Specialization:

ANALYTICAL CHEMISTRY

THEORY

<u>Paper No.</u>	<u>Title of the Paper</u>	<u>Marks</u>
Paper-V	<i>Environmental Chemistry</i>	75 Marks
Paper-VI	<i>Elementary Analytical Chemistry</i>	100 Marks
Paper-VII	<i>Electroanalytical and Chromatographic Techniques</i>	100 Marks
Paper-VIII	<i>Spectroscopy and Electronics</i>	100 Marks

PRACTICALS

Practical-I	<i>Environmental Chemistry</i> (Practicals/Research Project)	25 Marks
Practical-II	<i>Instrumental Method of Analysis</i>	100 Marks
Practical-III	<i>Advanced Analytical Chemistry</i> <i>Practicals or Research Project (Thesis)</i>	100 Marks
Total Marks		600 Marks

Theory

1. Fossil Fuels and Energy Sources:

Origin and development of coals: 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, conversion 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 particulations, sulphur oxides, effects of sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, 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.

RECOMMENDED BOOKS

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

Paper-VI: ELEMENTARY ANALYTICAL CHEMISTRY Marks: 100

Theory

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, medium, mode and geometric mean, dispersion, standard deviation, mean deviation and their significances, confidence limits for the mean and standard deviations, comparison of standard deviations, inference from the tests, 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.

- a. Ionic substances: Strong electrolytes and weak electrolytes, activity, mean activity and activity coefficients.
- b. Acids and bases and the effect of various solvents on acidity and basicity, protic, aprotic and amphiprotic solvents, calculation and computation of stepwise dissociation constants, calculation and dissociation of stepwise dissociation constant from experimental data, the preparation use and effectiveness of buffers, different techniques of pH determinations

3. Precipitation:

Solubility and solubility product, effects of salts, solvents hydration hydrolysis, pH changes, ageing surface exchange, adsorption on precipitates. Determination of errors in gravimetric analysis, thermogravimetric methods for testing of thermal stability, DTA and TGA: Basic principles, instrumentation and applications.

4. Automation in Analytical Chemistry:

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

RECOMMENDED BOOKS

1. Analytical Chemistry by Gary D. Christian; 6th ed. 2004; John Wiley & Sons, Inc.
2. G. D. Christian and J.E. Reilly; "Instrumental analysis" Allyn and Bacon, Inc.
3. Douglas A. Skoog, and D.M. West, "Principle of Instrumental analysis" einholt, New York.
4. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, "Fundamentals of Analytical Chemistry" 8th ed. 2003; Saunders College Publishing, Philadelphia.
5. Instrumental Methods of Analysis by Hobert H. Willard D.L. Merrit & J.R.J.A. Dean, Frank A. Settle; 7th Sub edition 1988; Wadsworth Publishing Company.
6. Laboratory Manual of Analytical Chemistry by C. Reilly; Allyn and Bacon, London.
7. Quantitative Analysis by W. J. Blaedal and V. W. Medloche; Harper & Row, N.Y.
8. J.G. Dick, Analytical Chemistry, McGraw-Hill, Tokyo.

Paper-VII:

ELECRONALAYTICAL AND CHROMATOGRAPHIC

TECHNIQUES

Marks: 100

Theory

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 ions buffers. Complexometric titrations.

2. Electrode Phenomena:

The electrochemical cell, Oxidation and reduction 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 measurements, potentiometric titration.

3. Chromatography:

Adsorption and distribution laws as applied to chromatography, the displacement, Frontal methods of analysis and elution techniques:

- a. Column paper and thin layer chromatography, suitable system for the analysis of some simple organic substances, reversed-phase chromatography, high-pressure liquid chromatography.
- b. Gas chromatography; GSC and GLC, parameters governing gas phase separations, simple instrumentation for gas chromatography, suitable system for analysis, high temperature programmed analysis.
- c. Electrophoresis; paper electrophoresis, constant current and constant potential paper electrophoresis.

4. Principles of Polarography:

Principles of polarography, instrumentation, different modes of polarography. Application of the inorganic and organic analysis. Principles of stripping voltametry, types of stripping voltametry and applications, analysis of cations and anions.

5. Radiochemical Methods:

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

BOOKS RECOMMENDED

1. D.A. Skooge and D.M. West, Principle analysis, McGraw-Hill Book Company; New York.
2. R.D. Braun, Introduction to chemical analysis, McGraw-Hill Book Company; New York.
3. G.D. Christian and J.E. Reilly, Instrumental analysis, Allyn and Bacon Inc; New York.

Paper-VIII: SPECROSCOPY AND ELECTRONICS Marks: 100

Theory

1. Elements of Electricity and Electronics:

- 1.1 The characteristics of alternating and direct current, Series and parallel circuits involving resistors, inductors and capacitor current, voltage and impedance measuring devices.
- 1.2 The thermoionic tubes: introduction to the diode, triode, tetrode and pentode, vacuum tubes. Characteristic curves for these tubes, Simple circuits involving rectification, amplification and power stabilization. Special electron tubes such as cathode ray tube, phototube, gas filled tubes etc. and their ordinary uses.
- 1.3 The transistors and thermistors: Introduction to thermistors and transistors and their uses.

2. Optical Methods:

Ultraviolet, visible spectroscopy. Various sources of light. Types of prisms and gratings. Monochromators and their efficiency. The construction and optics of typical spectrograph and of typical spectrophotometer (UV-Visible). The analytical use of spectrograph. The use of a spectrophotometer in the analysis of one component or multicomponent systems. Sources of error and optimum conditions.

3. Atomic Spectroscopy:

Atomic absorption spectrophotometers and atomic fluorescence spectrometer, and flame photometry.

- 3.1 Principles of flame photometry, instrumentation, application of flame photometry and interferences.
- 3.2 Principles of atomic absorption and atomic fluorescence, instrumentation, analytical parameters and analytical applications.
- 4. NMR Spectroscopy:**
Principles and interpretation of spectra.
- 5. Mass Spectrometry:**
Basic Principles, instrumentation and applications.
- 6. UV-Visible and Photoluminescence:**
Molecular absorption of radiation, effect of structure on absorption, magnitude of absorption of radiation, quantitative absorption spectroscopy, applications, apparatus and instruments. Principles of photoluminescence, fluorescence and phosphorescence, instrumentation and applications of fluorescence spectroscopy.

RECOMMENDED BOOKS

1. G.D. Christian and J.E. Reilly, Instrumental analysis, Allyn and Bacon Inc; New York.
2. R.D. Braun, Introduction to chemical analysis, McGraw-Hill Book Company; New York.
3. Bernhard Wetz, Atomic absorption spectroscopy, Verlay Chemie, New York.
4. Willard, Meritte and Dean, Instrumental analysis, D. Van Nostrad, New York.
5. K.C. Thompson and R.J. Reynold, Basic electronics, Charles Griffin and Co. London.
6. A. Marcus and Gendler, Basic electronics, Engle Wood Printice Hall.

PRACTICALS:

- I. Environmental Chemistry Practicals or Research Project: 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 fluoride 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 nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
7. Determination of caffeine in tea leaves by HPLC.

II. Advanced Instrumental Chemistry

Marks: 100

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 methods.
5. Analysis and quantitation of various pharmaceutical samples.
6. Determination of stepwise ionization constant of H_3PO_4 .
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.
10. Separation of the given mixture by TLC.

III. Instrumental Methods of Analysis/Practicals

Marks: 100

1. Determination of phenol in a given sample by spectrophotometric method.
2. Determination of tannin in tea leaves by spectrophotometric method.
3. Determination of nitrates and nitrite in a given water sample by spectrophotometric method.

4. Determination of ammonia in polluted water samples by spectrophotometric method.
5. Determination of the formula and stability constants by spectrophotometric method.
6. Determination of organic matter in a given sample by spectrophotometric method.
7. Determination of sulphanilamide in the given drug by spectrophotometric method.
8. Determination of pKa value of an indicator drug by spectrophotometric method.
9. Determination of sulphide in the given sample by spectrophotometric method.
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.

Field of Specialization:

APPLIED CHEMISTRY

THEORY

<u>Paper No.</u>	<u>Title of the Paper</u>	<u>Marks</u>
Paper-V	<i>Environmental Chemistry</i>	75 Marks
Paper-VI	<i>Polymer Chemistry</i>	100 Marks
Paper-VII	<i>Metallurgy</i>	100 Marks
Paper-VIII	<i>Unit Operation</i>	100 Marks

PRACTICALS

Practical-I	<i>Environmental Chemistry</i> (Practicals/Research Project)	25 Marks
Practical-II	<i>Instrumental Method of Analysis</i>	100 Marks
Practical-III	<i>Advanced Applied Chemistry</i> <i>Practicals or Research Project (Thesis)</i>	100 Marks
Total Marks		600 Marks

Theory

1. Fossil Fuels and Energy Sources:

Origin and development of coals: 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, conversion 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 particulations, sulphur oxides, effects of sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, 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.

RECOMMENDED BOOKS

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

Paper-VI

POLYMER CHEMISTRY

Marks: 100

Theory

- 1) Addition polymerization, co-ordination polymerization, polymerization with supported metal oxide catalyst. Polymerization techniques, Polymer characterization. Crystalline and amorphous states of polymers.
 - 1.1) Plastics: Celluloids, Phenol formaldehyde, urea and melamine formaldehyde, polyethylene, polyvinyl acetates.
 - 1.2) Rubber: Natural rubber processing, vulcanization of rubber, neoprene rubber, Tiokol rubber, polyurethane rubber.
 - 1.3) Fibers: Viscose rayon, cuprammonium rayon, cellulose acetate rayon, Nylon-6, Nylon 66, Acrylic and modacrylic fibers, vinyl and vinylidene fibers.
- 2) **Petrochemicals:**
Thermal cracking of ethane, propane, naphtha, catalytic and steam reforming process, oxidation, halogenation, aromatic substitution, hydrolysis, hydration, hydrogenation, hydroformylation and esterification processes.
- 3) Types of dyes, manufacture of dyes and dye intermediates, application of dyes.
- 4) **Explosives:**
Industrial and military explosives, military gases.
- 5) **Detergents:**
Mechanism of detergents, manufacture of detergents.

RECOMMENDED BOOKS

1. Billmeyer, F. W. Jr., Text Book of Polymer Science, 3rd Ed., John Wiley and Sons Inc. Singapore, (1994).

2. L.H Sperling “Introduction to Physical Polymer Sciences”, 2nd Ed., John Wiley & Sons
3. Joel R. Fried “Polymer Science & Technology”, Prentice Hall, Inc. (1995).
4. G. Odioin “Principles of Polymerization”, 2nd Ed. John Wiley & Sons .
5. Cowie J. M.G., Polymers Chemistry and Physics of Modern Material, 1st Ed. Intertext Book New York, (1973).
6. R. N. Shreve, The chemical process industries, McGraw-Hill Book Company.
7. Terold M. Schultz, Polymer Materials Science, (1974).
8. Riegel, E.R. (1956).” Industrial Chemistry” 5th ed. Reinhold Publishing Corporation, New York.
9. W Francis, Fuels and fuel technology, Pergamon press, New yourk.
10. Theodore Dumas Walter Bulani, Oxidation of Petrochemicals Chemistry and Technology, (1974).
11. Urbanski, T., Chemistry and Technology of Explosives Vol-1, Authorised Translation by I. Jeczalikowa ad S. Laverton, 2nd Ed., Pergamon Press London, (1983).
12. Urbanski T., Chemistry and Technology of Explosives Vol-II, Authorised Translation by W. Ornaf and S. London, 2nd Ed., Pergamon Press London, (1983).
13. Urbanski, T., Chemistry and Technology of Explosives Vol-III, 1st Ed., Pergamon Press London (1984).
14. Urbanstri, T., Chemistry and Technology of Explosives, (1985).
15. P. C. Deb, Soaps and Detergents, 1st Edition, C. B. S. Publisher and distributes, (1996).
16. P. C. Deb., Modern Trends in Formulating Soaps and Detergents, (1996).
17. R. M. Christie, Colour Chemistry, The Royal Society of Chemistry, (2001).

Paper-VII

METALLURGY

Marks: 100

Theory

- 1) Metallic ores, concentration of ores, metallurgy of iron, copper, aluminum, Magnesium, nickel and zinc.
- 2) **Protective Coatings:**
Manufacture and application of paint, Varnishes, Lacquers enamel and metallic coatings.
- 3) Ceramic and refractory raw materials, manufacture, properties and uses of ceramics products.
- 4) **Lubricants:**
Mechanism of lubrication, Manufacture of different types of lubricants.
- 5) **Corrosion:**
Direct oxidation of metals and alloys, electrochemical corrosion, corrosion failure, corrosion testing.

RECOMMENDED BOOKS

1. Evans, U. R., An Introduction to Metallic Corrosion, 3rd Ed., Edward Arnold (1981).
2. Mattsson, E. Basic Corrosion Technology for Scientists and Engineers, 1st Ed., Ellis Horwood, Ltd. UK (1989).
3. Ijaz Hussain Khan, Corrosion Technology, Vol. I (1989).
4. A Catterll, Introduction to metallurgy.
5. A.R. Bailey, A text book of metallurgy, Macmillan, London.
6. Riegel, E.R. (1956).” Industrial Chemistry” 5th ed. Reinhold Publishing Corporation, New York.
7. R. Lambourne., Paint & Surface Coatings Theory & Practice, (1987).
8. W. F. Ford, The Effect of Heat on Ceramics, (1967).
9. Philip Rawson, Ceramics, (1971).
10. Wyatt, Metal Ceramics & Polymers, (1974).
11. F. K. Norton, Elements of Ceramics, 2nd Ed., (1974).
12. Irene Stitt, Ceramics last 100 years, (1974).
13. Kingery Bowen Uhlman, Introduction to Ceramics, 2nd Ed., (1976).
14. F.H.Norton, Refractories 4th Ed., McGraw Hill Book Company, (1970).

15. R. N. Shreve, The chemical process industries, McGraw-Hill Book Company.
16. W. L. Nelpon., Petroleum Refinery Engineering, 4th Ed., (1985).
17. Theodore Dumas Walter Bulani, Oxidation of Petrochemicals Chemistry and Technology, (1974).
18. Lieghore, Chemistry of engineering materials” McGraw Hill Book Company, New york.

Paper-VIII

UNIT OPERATION

Marks: 100

Theory

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, Roults and Henry’s Law of potential 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 crystallizers.

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.

RECOMMENDED BOOKS

- 1 Warren L. McCabe Julian C. Smith Peter Harriott., Unit operations of Chemical Engineering, 4th Ed., (1985).
- 2 J. M. and J.F. Richardson, Chemical Engineering, Vol I & II. Pergmon Press, New York.
- 3 Badger and Bencherio, An introduction to chemical Engineering, McGraw Hill Book Company, New York.

PRACTICALS:

I. Environmental Chemistry Practicals or Research Project: Marks: 25

II. Advance Applied Chemistry Analysis/Research Project Marks: 100

- 1) Chemical examination of various vegetable and animals oil.
- 2) Analysis of various Pakistani ores
- 3) Physical testing of cement
- 4) Analysis of leather.
- 5) Analysis of sugar

III. Instrumental Methods of Analysis/Practicals: Marks: 100

1. Potentiometric titrations
2. Conductometric titration
3. Electrogravimetric analysis
4. Flame photometric analysis
5. Paper chromatography, ion exchange chromatography
6. Spectrophotometric analysis

Field of Specialization:

BIOCHEMISTRY

THEORY

<u>Paper No.</u>	<u>Title of the Paper</u>	<u>Marks</u>
Paper-V	<i>Environmental Chemistry</i>	75 Marks
Paper-VI	<i>Biochemistry of Macromolecules and Techniques</i>	100 Marks
Paper-VII	<i>Nutrition/Physiological Chemistry</i>	100 Marks
Paper-VIII	<i>Microbiology and Immunology</i>	100 Marks

PRACTICALS

Practical-I	<i>Environmental Chemistry</i> (Practicals/Research Project)	25 Marks
Practical-II	<i>Instrumental Method of Analysis</i>	100 Marks
Practical-III	<i>Advanced Biochemistry</i> <i>Practicals or Research Project (Thesis)</i>	100 Marks
Total Marks		600 Marks

1. Fossil Fuels and Energy Sources:

Origin and development of coals: 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, conversion 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 particulations, sulphur oxides, effects of sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, 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.

RECOMMENDED BOOKS

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

Paper-VI BIOCHEMISTRY OF MACROMOLECULES AND TECHNIQUES

Marks 100

Theory

1. Enzyme Structure and Functions

Chemical nature, nomenclature and classification of enzymes. Enzyme kinetics. Michaelis-Menton equation. Thransformation 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 catalytic efficiency. Some reaction mechanisms of enzyme active sites, regulatory enzyme, isozymes.

2. Endocrinology:

Chemistry, metabolism and biological functions of pituitary gland, thyroid, Parathyroids, adrenal, gonadal, and pancreatic hormones, pheromons.

3. Biochemical Research Techniques:

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

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

Paper-VII NUTRITION/PHYSIOLOGICAL CHEMISTRY

Marks: 100

Theory

1. Nutrition:

Principle 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 tear.
- 2.3. Chemistry of respiration and gas transport
- 2.4. Renal function, acid-base balance, electrolytes and water balance.
- 2.5. Composition and metabolism of specialized tissues.

Paper-VIII MICROBIOLOGY AND IMMUNOLOGY

Marks: 100

Theory

1. Microbiology and Industrial Fermentation:

General morphology and cytology of micro organisms. An introduction to the orders and families of micro-organisms. Methods of isolation and classification. General effects of environments of micro organisms. Nutrition of microorganism. Introduction to industrial microbiology. Growth kinetics and oxygen transfer. Application of chemostat and turbidostat. Microbial production of alcohols, citric acid and acetic acid and their mechanism. Antibiotic and enzyme production. Nutritional biomass.

2. Chemotherapy and Immunology:

Structure activity relationship and mode of action of antipyretics, arsenides, antimalarials, sulpha drugs and antibiotics 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.

RECOMMENDED BOOKS

1. Lehninger, A. L., "Principles of Biochemistry", Worth Publisher, New York, (2001).
2. Voet, D. and Voet J. G., "Biochemistry", John Wiley & Sons, New York, (2000).
3. Murray, R. K., Mayes P. A., Granner, D. K. and Rodwell, V. W., Harper's Biochemistry", Appleton & Lange (2000).
4. Robert, Harper's Biochemistry", 25th Ed, (2000).
5. West, Text Book of Biochemistry", 4th Ed., (2000).
6. Zubay, G., Biochemistry, 4th Ed., Macmillan Publishing Co. (1999).
7. Bhagavan. N. V., Biochemistry, 2nd Ed., J.B. Lippincott Company (1978)
8. Plummer, D.T., An introduction to practical biochemistry, TATA McGraw-Hill Publishing Company LTD.
9. Wilhelm R. Frisell, "Human Biochemistry", Macmillan Publishing Co., Inc. New York (1982).
10. Guyton AC and Hall JE, "Text Book of Medical Physiology", 9th Ed, W. B. Saunders Company, Tokyo, (1996).
11. Devlin, T. M. (Editor), The Text Book of Biochemistry with Clinical Correlation, Wiley- Liss, New York (1997).

12. Principles and techniques of practical Biochemistry by William Edward and Arnold.
13. Watson, J.D., Baker, T.A., Bell, S.P., Gann, Molecular Biology of the Gene 2004, Pearson Education, Inc.
14. Watson, J.D. Tooze, J and Kurtz, D.T. Recombinant DNA Scientific American Books. Freeman.
15. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter Molecular Biology of the Cell 5th Edition Taylor & Francis.
16. T. A. Brown. Genomes 3rd Edition, Taylor & Francis.
17. Nester, E.W. D.G. Anderson, C.E. Roberts, N.N Pearsall and M.T. Nester. Microbiology 4th Ed. McGraw Hill Companies Inc.
18. Doan T., R.Melvold, S.Viselli and C. Waltenbaugh. Immunology: Lippincott Illustrated Reviews Lippincott Williams& Wilkins.
19. Stroll, W.A. H.Rouse, P.C. Champe, and R.A. Harvey. Microbiology Lippincott Illustrated Reviews Lippincott Williams& Wilkins.
20. Shils, M.E., J.A. Olson and M. Shike. Modern Nutrition in Health and Disease. Lea & Febiger USA.
21. Passmore, R and M.A. Eastwood. Human Nutrition and Dietetics. Churchill Livingstone.
22. Gowenlock, A. H., Varley's Practical Clinical Biochemistry, 6th Ed., Heinemann Professional Publishing, Oxford (1988).

PRACTICALS:

- I. **Environmental Chemistry Practicals or Research Project:** **Marks: 25**

- II. **Advance Biochemistry Analysis/ Research Project:** **Marks: 100**
 - i. Analysis of Urine.... complete.
 - ii. Analysis of blood complete including blood group
 - iii. Preparation of different media for growing micro-organisms

- iv. Sterilization techniques
- v. Growth and identification of micro-organism
- vi. Enzymes: Study of functions and properties
- vii. Biochemical preparations (2-3 preparation) i.e:
 - 7.1 Preparation of glycogen 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 phosphatase etc.

Their preparation, purification or characterization by different physico-chemical.

III. Instrumentation Methods of Chemical Analysis/Research Project Marks: 100

- 1) **Paper chromatography:**
One dimensional and two dimensional for carbohydrates and protein
- 2) **Thin layer chromatography:**
Silica gel and impregnated silica gel (with AgNO₃ or borate) for lipids, fatty acids and sterols.
- 3) **Ion exchange chromatography:**
Elements, Mg, Al, etc, found in the biological fluids or food
- 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 chromatography, HPLC, etc.

Field of Specialization:

INORGANIC CHEMISTRY

THEORY

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

PRACTICALS

Practical-I	<i>Environmental Chemistry (Practicals/Research Project)</i>	25 Marks
Practical-II	<i>Instrumental Method of Analysis</i>	100 Marks
Practical-III	<i>Advanced Inorganic Chemistry Practicals or Research Project (Thesis)</i>	100 Marks
Total Marks		600 Marks

Theory

1. Fossil Fuels and Energy Sources:

Origin and development of coals: 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, conversion 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 particulations, sulphur oxides, effects of sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, 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.

RECOMMENDED BOOKS

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

Paper-VI MECHANISM OF INORGANIC REACTIONS BIO-INORGANIC CHEMISTRY

Marks: 100

Theory

1. Nomenclature:

A review of the theories of coordinate bond; The VBT, The CFT and its applicatios, the MOT (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, nature of the haemo-dioxygen binding, model systems,

cooperativity in haemoglobin, cytochromes, P450 enzymes, iron sulphur protein, ferredoxins, haemoerythrins, the biochemistry of Zn, Cu, Co and alkaline earths.

RECOMMENDED BOOKS

1. F.A. Cotton and S. Wikinson, Advanced inorganic chemistry, John Wiley and Sons, New York.
2. F. Basolo and R. Johnson, Mechanisms of inorganic reactions, John Wiley and Sons, New York.
3. F. Basolo and R. Johnson, Coordination chemistry, W.A. Banerjee, Row Publishers, New York.
4. J.E. Huheey, Inorganic chemistry, Harper and Row Publishers, New York.
5. D. Johnson, Mechanism of inorganic reaction in solutions, McGraw-Hill, London.
6. G.L. Gunther and Eichhor, Bioinorganic, Allyn, Boston.
7. M.L. Tobe, Studies in modern chemistry.

Paper-VII SPECTROSCOPY AND INSTRUMENTAL METHODS OF ANALYSIS

Marks: 100

Theory

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, application of the principles related to electronic transition, structural evidence from electronic spectra, basic instrumentation of IR to application of group theory in IR and Raman for simple molecules.

3. Vibration and Rotation Spectroscopy:

- Infrared, Raman and microwave, applications of infrared and Ramanspectroscopy 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 application of NMR to structure determination.
 - 5. Emission Spectroscopy:**
Origin of spectra, excitation methods, spectrographs, qualitative identification.
 - 6. Conductance Methods:**
Electrolytic conductivity, instrumentation, conductometric titrations, basic principles of polarography.
 - 7. Chromatography:**
Paper chromatography, TLC, GLC, HPLC and ion exchange chromatography.
 - 8. Mass Spectrometry:**
Theory and applications to simple molecules.

RECOMMENDED BOOKS

1. Russell.s. Drago, Physical methods in inorganic chemistry, Van Nostrand Rein Hold, New York.
2. M.H. Willard, L.L. Merrite, Jr. J.A. Dean, Instrumental methods of analysis, Van Nostrand, New York.
3. C.N. Banewale, Fundamentals of molecular spectroscopy, McGraw-Hill, New York.
4. F.A. Cotton, Chemical applications of group theory, John Wiley and Sons, New York.
5. H.G. Gassidy, Fundamental Chromatography, Interscience Publications, New York.
6. F. Helfforich, Ion exchange, McGraw-Hill, New York.

Paper- VIII

NUCLEAR AND RADIO CHEMISTRY

Marks: 100

Theory

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 Radiation:

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. Application of Nuclear Science:

A) Isotopes 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. G.F. Friedlander, J.W. Kennedy and J.M. Miller, Nuclear and radio chemistry, 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. W.M. Gibbson, Nuclear reactions, Penguin book Inc., New York.
5. J.M. Ried, The atomic nuclear reactions, Penguin book Inc., New York.
6. Chopman and Rydberg, Nuclear Chemistry, Printice Hall, New York.

PRACTICALS

- I. Environmental Chemistry Practical or Research Project: Marks: 25**

II. Advanced Inorganic Chemistry Labs or Research Project: 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 Practicles: Marks: 100

1. **Selected calorimetric methods:**
 - 1.1 Determination by manganese as permanganate.
 - 1.2 Simultaneous determination of binary mixtures.
 - 1.3 Relative concentration errors 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 methods:**

RECOMMENDED BOOKS

1. H.H. Willard, K.K. Merritt and J.A. Dean, Instrumental methods of analysis, von Nostrand, New York.
2. G.F. Kennedy and J.M. Miller, Nuclear and radio chemistry, John Wiley and Sons, New York.
3. Kaplan Traving, Nuclear Physics, Pak Publishers Karachi.
4. Glasstone Samuel, Source book on atomic energy, Van Nostrand, New York.
5. W.M. Gibbson, Nuclear reactions, Penguin book Inc., New York.
6. J.M. Ried, The atomic nuclear reactions, Penguin book Inc., New York.

Field of Specialization:

ORGANIC CHEMISTRY

THEORY

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

PRACTICALS

Practical-I	<i>Environmental Chemistry</i> (Practicals/Research Project)	25 Marks
Practical-II	<i>Instrumental Method of Analysis</i>	100 Marks
Practical-III	<i>Advanced Organic Chemistry</i> <i>Practicals or Research Project (Thesis)</i>	100 Marks
Total Marks		600 Marks

1. Fossil Fuels and Energy Sources:

Origin and development of coals: 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, conversion 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 particulations, sulphur oxides, effects of sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, 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.

RECOMMENDED BOOKS

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

Paper-VI:

HETEROCYCLIC CHEMISTRY

Marks: 100

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 rules:

2.1: Introduction, excitation and the excitation state.

2.2: Intermolecular reactions of the olefinic bond.

2.3: Intermolecular reactions of the carbonyl group.

2.4: Intermolecular cycloaddition reactions.

2.5: Generalized woodward and Hofmann rules for concerted reaction.

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: A, B₁, B₂, B₁₂, C, D and E.

3.3: Steroids:

General introduction, Cholesterol and sex hormones.

Paper-VI:

OXIDATION REDUCTION

Marks: 100

1. Reduction

1.1: Catalytic hydrogenation and dehydrogenation, catalysts, solvents and equipments, reduction of functional groups, mechanism and stereochemistry, dehydrogenation reaction.

1.2: Metal hydrides reductions and related reactions.

1.3: Hydroboration and related reactions.

1.4: Dissolving metal reduction and related reactions.

1.5: Staudinger Reduction, Fukuyama Reduction

2. Oxidation:

2.1: Oxidation with chromium and manganese compounds (Oxidation of alcohols, aldehydes, carbon-carbon double bonds and carbon-hydrogen bond 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 tetra-acetate, mercuric acetate and selenium dioxide)

2.4; Swern Oxidation, Corey-Kim Oxidation

3. Organometallic Compounds:

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

4. Reactive Intermediates and Molecular Rearrangements:

4.1: Carbonium ions, carbanions, free radicals, benzyne and nitrenes.

4.2: anionotropic, Cationotropic rearrangements and free radical rearrangements.

Paper-VIII: SPECTRAL ANALYSIS OF ORGANIC COMPOUNDS Marks: 100

1. Infrared Spectroscopy:

1.1: Molecular vibration

1.2: Mechanics of Measurements.

1.3: Applications of infrared spectroscopy

1.4: Absorption of common functional groups.

1.5: Problems

2. Ultraviolet Spectroscopy.

2.1: Mechanics of Measurements.

2.2: Electronic Excitation.

2.3: Simple chromophoric groups.

2.4: Conjugated system.

2.5: System of extended conjugation.

2.6: Aromatic system

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 measurements.
- 3.7: Shielding mechanisms.
- 3.8: Correlation; hydrogen bond 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 sampling handling.
- 4.2: Basic aspects of mass spectroscopy.
- 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 spins resonance.

PRACTICALS:

I. Environmental Chemistry Practicals or Research Project: Marks: 25

II. Advanced Organic Chemistry Practicals or Research Project: Marks: 100

- 1. Many step synthesis of organic compounds. (To be organized by the teacher concerned).

2. Synthesis Organic Compounds by “Named Organic Reaction” e.g;

- 2.1. Clemmensen reduction (Diethylether).
- 2.2. Perkin reaction (phenyl acetic acid).
- 2.3. Friedal Crafts reaction (acetoacetic ester).
- 2.4. Grignard reacrion (triphenyl carbinol).

OR Any other reactions depending upon the availability of chemicals and equipment.

In some of the above synthesis the students be asked to record the IR spectra of the starting material and the product of the reaction to follow the reaction and 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:

Estimation of aldehydes, ketones and esters.

III. Instrumental Methods of Analysis/Practicals:

Marks: 100

1. Paper Chromatography:

- 1.1 Chromatography, ascending; the separation of the component of commercial inks.
- 1.2 Chromatography, ascending; the 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 ways, the separation and detection of amino acids in fruit juices or ink.
- 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 Separations 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 Separations of ink pigments by thin layer chromatography, separation of amino acids by thin layer chromatography.
 - 3.2 The recovery by elution of substances from thin layer.
4. **Column Chromatography:**
 - 4.1. Separation of 2,4-dinitrophenyl hydrazones.
5. **Refractometry:**
 - 5.1. To find the one 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.

RECOMMENDED BOOKS:

1. F. g. Mann and B. C. Sounders, Practical organic chemistry, Longmann, London.
2. I. vogel, a text book of practical organic chemistry, Longmann, London.
3. Elidge and sammes, Acourse in modern technique of organic chemistry, Butterworths, London.
4. R. L. Dannley, J. D. Cram, experimental organic chemistry, the Macmillan Co. New York.
5. Mikes, Laboratory and hand book of chromatographic methods, van Nostrand, new York.
6. Addison Ault, Techniques and experiments for organic chemistry, Holbrook press, Boston

Field of Specialization:

PHYSICAL CHEMISTRY

THEORY

<u>Paper No.</u>	<u>Title of the Paper</u>	<u>Marks</u>
Paper-V	<i>Environmental Chemistry</i>	75 Marks
Paper-VI	<i>Quantum Chemistry and Spectroscopy</i>	100 Marks
Paper-VII	<i>Statistical Mechanics, Thermodynamic and Solution Thermodynamics</i>	100 Marks
Paper-VIII	<i>Surface Chemistry and Advanced Chemical Kinetics</i>	100 Marks

PRACTICALS

<u>Practical No.</u>	<u>Title of the Practical</u>	<u>Marks</u>
Practical-I	<i>Environmental Chemistry (Practicals/Research Project)</i>	25 Marks
Practical-II	<i>Instrumental Method of Analysis</i>	100 Marks
Practical-III	<i>Advanced Physical Chemistry Practicals or Research Project (Thesis)</i>	100 Marks
Total Marks		600 Marks

Theory

1. Fossil Fuels and Energy Sources:

Origin and development of coals: 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, conversion 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 particulations, sulphur oxides, effects of sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, 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.

RECOMMENDED BOOKS

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

Paper-VI: QUANTUM CHEMISTRY AND SPECTROSCOPY Marks: 100

Theory

1. Quantum Chemistry

1.1: Some Basic Mathematical Concepts:

Operator, complex number, 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 law 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 Study State Schrodinger Equation:

- i. System with constant potential energy, free particles, particle in boxes, system involving potential well of finite height.
- ii. System for which the potential energy is not constant, the one dimensional harmonic oscillator the hydrogen molecular ion H^{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, spectroscopy.

2.2: The Vibrational Spectra of Diatomic Molecules:

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

3.3: Rotational Spectra of Molecules:

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

3.4: Electronic Spectra of Diatomic and Polyatomic Molecules:

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

RECOMMENDED BOOKS:

1. W. Kauzman. "Quantum Chemistry", Academic press, New York.
2. Frank J. Bockhoff, Elements of quantum theory, 2nd edition, Addison, London.
3. G. M. Barrow, Introduction to molecular spectroscopy, McGraw-Hill, New York.
4. G. M. Barrow, The Structure of molecules, Benjamin, New York.
5. G. Herberg, Atomic spectra and atomic structure, Dover Publication, New York.
6. Herberg, Spectra of Diatomic molecules, Dover Publication, New York.
7. C. N. Banwell, Fundamentals of molecular spectroscopy, McGraw-Hill, New Delhi.

Paper-VII: STATISTICAL MECHANICS, THERMODYNAMIC AND SOLUTION THERMODYNAMICS Marks: 100

Theory

1. Statistical Distribution:

Formulations, probability, most probable distribution.

2. Partition Function:

Factorisability of partition function, translational and vibrational rotations, electronic and nuclear partition functions.

3. Statistical Thermodynamics:

The statistical formulation of the functions of the thermodynamics, theory work and heat, enthalpy entropy and free energy.

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 solution, Raoult's Law, heat of mixing, solubility of solid and gases, Henry's law, colligative properties of solution, activities and activity co-efficients and their measurement, statistical mechanics of non-ideal solution.

RECOMMENDED BOOKS:

1. E. A. Moelwyn-hughes, Physical chemistry, Pergamon Press, Oxford.
2. F. T. Wall, Chemical thermodynamics, Freeman, San Francisco.

Paper- VIII:

**SURFACE CHEMISTRY AND ADVANCED CHEMICAL
KINETICS**

Marks: 100

Theory

1. Surface Chemistry:

Adsorption in general, Modern trends in adsorption, scope of adsorption in physical chemistry, Low cost adsorbents, surface chemistry of adsorbents. characterization of adsorbents with special reference to surface functional groups, elemental analysis, surface morphology, surface phases and surface area. Methods for the activation of adsorbent. Solid-liquid interfaces, selection of adsorbate and adsorbent for adsorption, Adsorption kinetics, Effect of contact time, Equilibrium studies, Different forms of adsorption isotherms and its usefulness for the adsorption process. Henry's equation, Gibbs adsorption equation, BET equation and its applications, Factors affecting the process of adsorption-pH, adsorption temperature, adsorbent dose, surface area and adsorbate size etc.

2. Advanced Chemical Kinetics:

A review of common experimental methods and treatments of kinetics data. Temperature dependence of the rates of reactions. Opposing reactions, consecutive reactions, parallel reactions, different theories for finding reaction rates (collision and transition rate theories) and their comparison. Primary salt effect in ionic reactions.

RECOMMENDED BOOKS:

26. R. A. Alberty, J.S. Robert and G. B. Mounqi "Physical Chemistry", 4th ed. John Wiley and Sons (2004).
27. P.W. Atkins, "Physical Chemistry", 6th ed., W.H. Freeman and Co. New York (1998).
28. R.C. Bansal, J. B. Donnet,; F. Stoeckli, "Active Carbon", Marcel Decker, New York, 1988.
29. G. .M. Barrow, "Physical Chemistry", 5th ed., McGraw Hill (1992).
30. I. Chorkendorff and J.W. Niemantsverdriet, "Concept of Modern Catalysis and Kinetics", 1st ed., John Wiley and Sons (2003).
31. B. Eduardo, T. Juan, "Adsorption by Porous Carbon", 2008, Imprint Elsevier, Pages 776.
32. M. Harry, "Activated Carbon", Imprint. Elsevier, 2006, Pages 554.
33. J. W. Hassler, "Purification with Activated Carbon", Chemical Publishing CO. INC. New York, 176 (1974).
34. J. W. Patrick, "Porosity in Carbons: Characterization and Applications", Edward Arnold, London, 1995.
35. J. Rouquerol, F. Rouquerol, K. Sing. "Absorption by Powders and Porous Solids", 1998, Imprint Academic Press, Pages 467.

PRACTICALS:

- I. Environmental Chemistry Practicals or Research Project: 25 Marks
- II. Advanced Physical Chemistry Laboratory or Research Project: 100 Marks

(Special Practicals)

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

III. Instrumental Methods of Chemical Analysis/Practicals:

Marks: 100

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