...SITY OF DELHI

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SCHEME OF EXAMINATION

AND

COURSES OF READING

FOR

B.Sc. ANALYTICAL CHEMISTRY

Syllabus applicable for the students seeking admission to the B.Sc. Analytical Chemistry Course in the academic year 2011-12 and onwards

B.Sc Analytical Chemistry

Analytical Chemistry is an applied, experimental field of science and is based not only on chemistry, but also on physics, biology, information theory and many fields of technology. It is of fundamental importance not only to all branches of chemistry but also to all biological sciences, engineering sciences, health, medicine, pharmaceuticals, environment, industrial processes, quality control and implementation of legislation.

The objective of B.Sc Analytical chemistry course is to provide students exposure to chemistry, physics, biological sciences, environmental science, computer application, instrumentation and analytical techniques. In this three year course spread over six semesters, there are 12 papers of chemistry including 6 papers of analytical chemistry; 3 papers each of mathematics and physics and one paper each of intellectual property rights, biochemistry and environmental chemistry, technical writing and communication in English, computational skills. In the last two semesters of this course, there is a provision for two elective papers out of four papers, viz. green chemistry, polymer science, biotechnology and forensic science.

After graduating in Analytical Chemistry the students can pursue academics in Chemistry, bioinformatics, forensic science, biochemistry and other disciplines of inter-disciplinary sciences. They can also use it as a stepping stone to pharmaceutical industry and for Research and Development in industry.

Course Structure

All theory papers will have 5 periods per week, including 1 period for assignments, discussion, presentations, etc.

There shall be 6 practical classes per week for Chemistry and Analytical Chemistry.

In addition, there shall be one qualifying paper in self-learning mode called Environmental Studies.

Each Theory Paper shall be of 100 marks and Practical Paper shall be of 50 marks.

Total Number of Papers   : 24

Year I

Semester-1	Paper No.	Paper Name	Duration (Hrs.)	Maximum Marks
Paper 1	CHPT-101	Chemistry-I *	3	100
Paper 2	PHPT-101	Physics-1: Mechanics *	3	100
Paper 3	ACPT-101	Analytical Chemistry-I*	3	100
Paper 4	ENAT -101/ CSAT-101	Technical writing and Communication in English/ Computational skills*	3	100

* With Practicals

Semester-2	Paper No.	Paper Name	Duration (Hrs.)	Maximum Marks
Paper 5	CHPT-202	Chemistry-II*	3	100
Paper 6	MAPT-101	Calculus and Matrices	3	100
Paper 7	ICPT-202/ ACPT-202	Analytical Chemistry-II*	3	100
Paper 8	ENAT-101/ CSAT-101	Technical writing and Communication in English/ Computational skills*	3	100

* With Practicals

Year II

Semester-3	Paper No.	Paper Name	Duration (Hrs.)	Maximum Marks
Paper 9	CHPT-303	Chemistry-III*	3	100
Paper 10	MAPT-303	Algebra	3	100
Paper 11	ACPT-303	Analytical Chemistry-III*	3	100
Paper 12	Paper-602 (of B.Sc (H) Chemistry)	Biochemistry and Environmental Chemistry*	3	100

* With Practicals

Semester-4	Paper No.	Paper Name	Duration (Hrs.)	Maximum Marks
Paper 13	CHPT-404	Chemistry-IV*	3	100
Paper 14	PHPT-303	Physics-II : Wave and Optics*	3	100
Paper 15	ACPT-404	Analytical Chemistry-IV*	3	100
Paper 16	EL310 (vi)	Intellectual Property Rights	3	100

* With Practicals

Year III

Semester-5	Paper No.	Paper Name	Duration (Hrs.)	Maximum Marks
Paper 17	CHPT-505	Chemistry-V*	3	100
Paper 18	PHPT-404	Physics-III :Electricity, Magnetism and Electromagnetic Theory*	3	100
Paper 19	ACPT-505	Analytical Chemistry-V*	3	100
Paper 20	EL 310 (i) or EL 310 (ii) or EL 310 (iii) or EL 310 (iv)	Elective-I: Any one out of (i) Green Chemistry (ii) Polymer Science (iii) Biotechnology (iv) Forensic Science	3	100

* With Practicals

Semester-6	Paper No.	Paper Name	Duration (Hrs.)	Maximum Marks
Paper 21	CHPT-606	Chemistry-VI*	3	100
Paper 22	MAPT-404	Differential Equations	3	100
Paper 23	ACPT-606	Analytical Chemistry-VI*	3	100
Paper 24	EL 310 (i) or EL 310 (ii) or EL 310 (iii) or EL 310 (iv)	Elective-2: Any one out of (i) Green Chemistry (ii) Polymer Science (iii) Biotechnology (iv) Forensic Science which has been not opted in Semester 5	3	100

* With Practicals

SEMESTER I

PAPER-1

CHPT-101: CHEMISTRY-1 (ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS)

Section A: Inorganic Chemistry-1   **(30 Periods)**

Unit 1 Atomic Structure: *Recapitulation of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Need of a new approach to Atomic structure.*
What is Quantum mechanics? Time independent Schrodinger equation ($H \Psi = E\Psi$) and meaning of various terms in it. Significance of Ψ and Ψ^2, Schrodinger equation for hydrogen atom in Cartesian coordinates (x,y,z). Need of polar coordinates, transformation of Cartesian coordinates (x,y,z) into polar coordinates (r,θ,ϕ). Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distances with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_r and m_s. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit 2 Chemical Bonding and Molecular Structure
Ionic Bonding : General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

n :Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach : Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Section B: Organic Chemistry-1 (30 Periods)

Unit 3 Fundamentals of Organic Chemistry
Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckeløs rule.

Unit 4 Stereochemistry
Conformations w.r.t. ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds) . Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit 5 Aliphatic Hydrocarbons
Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
Alkanes:(Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbeøs synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.
Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzefføs rule); cis alkenes

and trans alkenes (Birch reduction). *Reactions:* ... trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

SUGGESTED READINGS

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
4. James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
5. T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
6. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
7. E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand
11. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
12. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
13. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
14. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

L CHEMISTRY

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry
1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)

   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

PAPER-2

PHPT 101: PHYSICS-1: MECHANICS

Vector calculus (Total Number of Lectures=15)
Differentiation of a vector with respect to a scalar, Gradient, divergence, Curl and Laplacian operations and their meanings. Idea of line surface and volume integrals gauss divergence theorem, Stokes theorem and Greens' theorem in Plane.

Mechanics (Total Number of lectures =30)
Dynamics of a system of particles, Centre of mass, Conservation of momentum. Newton's laws, Galilean invariance, Linear Momentum, Impulse, Work Energy theorem.

Potential energy, conservative and non-conservative forces.

Angular momentum of a particle and system of particles, Torque, Conservation of angular momentum, Rotation about a fixed axis, Moment of inertia and its calculation for rectangular, spherical and cylindrical bodies. Kinetic energy of rotation.

Motion of a particle in a central force field, Kepler's Laws (Only Statement).

Elasticity: Hook's Law, Stress, Strain, Elastic Constants, Twisting torque on a wire.

Special Theory of Relativity (Total number of lectures=15)

Constancy of speed of light, Michelson- Morley Experiment, Postulates of Special theory of Relativity, Lorentz transformations. Length contraction and Time Dilation. Theorem of Addition of relativistic velocities, Variation of mass with velocity. Equivalence of mass and energy, Doppler effect, Red shift.

SUGGESTED READINGS:

1. Schaum's Outline of Vector Analysis, 2nd Edn. - By Murray Spiegel, Seymour Lipschutz, Tata McGraw-Hill, (2009).

(S. Chand & Company Ltd., 2000).

ics course: By Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz and Burton Moyer, Tata McGraw-Hill-2007).

4. Physics, Vol. 1 and Vol. 11 by Robert Resnick, David Halliday and Kenneth S. Karane, (John Wiley and Sons, 5th Edition -1992).
5. Physics for Scientists and Engineers By Raymond A. Serway, John W. Jewett, John W. Jewett, Jr. (Brooks/Cole-2009).

PHPP-101: PRACTICAL PHYSICS

Note

1. Each college should set up ALL EXPERIMENTS.
2. Each student is required to perform at least 6 practicals in each semester.

Practical Exercises:

1. Determination of acceleration due to gravity using Kater's Pendulum.
2. Determination of the acceleration due to gravity using bar pendulum.
3. Determination of moment of inertia of a Fly wheel.
4. Determination of frequency of an electrically maintained tuning fork by Melde's experiment.
5. Determination of the coefficient of Viscosity of water by capillary flow method (Poiseuille's method)
6. Study of the condition of resonance for a series LCR circuit and determine its resonance frequency and Quality factor.
7. Single slit diffraction using laser.
8. Verification of Malus Law.
9. To determine the modulus of rigidity of a wire by Maxwell's needle.
10. To determine the elastic constants of a wire by Searle's method.
11. To Study the motion of a spring and calculate (s) spring constant and (b) the value of g.
12. Q factor of a mechanical oscillator.

1. Advanced Practical Physics: Worsnop and Flint, Methuen & Co, London.
2. Advanced Level Practical Physics: Nelson and Ogborn: English Language Book Society.
3. Practical Physics, Indu Prakash, Vol 1 and 2.

PAPER-3

ACPT-101: ANALYTICAL CHEMISTRY-1: BASIC PRINCIPLES & LABORATORY OPERATIONS

I. BASIC CONCEPTS:
A. Système international d'unités   **or SI Units**

 i) Definitions of the Seven Base Units (Mass, Length, Time, Temperature, Amount of substance, Electrical current and Luminous   intensity), Derived units, Conversion between units, Significant figures.

B. Chemical concentrations
  i)   Mole, molar mass
 ii) Calculations in grams and moles
iii) Solutions and their concentrations:

a) Molar concentration b) Analytical molarity c) Equilibrium molarity of a particular   species d) Percent concentration e) Parts per million/billion (ppm, ppb) f) Volume ratios for dilution procedures g) p-functions.

C. Preparing solutions: standard solutions, primary standards, secondary standards.

II. INTRODUCTION TO ANALYTICAL CHEMISTRY AND ANALYTICAL METHODS
   i)   General steps in chemical analysis
   ii) Introduction to methods of detecting analytes

- Physical
- Electromagnetic radiations
- Electric charge

ONS

- Single pan analytical balance: (operation and theory of the balance, construction details, errors in weighing, care of an analytical balance).
- Description and use of common laboratory apparatus: Volumetric flasks, burettes, pipettes, meniscus readers, weighing bottles, different types of funnels chromatographic columns, chromatographic jars, desiccators, drying ovens, filter crucibles, rubber policeman.
- Calibration and use of volumetric glass ware.
- pH meter: components of pH meter, use of pH Meter, maintenance of pH meter, application of data.
- Laboratory notebook.

IV. ERRORS IN CHEMICAL ANALYSIS

- Types of errors

- Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty.
- The Gaussian distribution, mean and standard deviation, confidence intervals.
- Statistical tests of data (the F test, the t test, Q test for bad data, the method of least squares).
- Calibration curve.
- Laboratory notebook.
- Safety with chemicals and waste.

ACPP- 101: PRACTICAL ANALYTICAL CHEMISTRY

1. Use and calibration of volumetric equipment (volumetric flasks, pipettes and burettes).
2. Preparation of standard solutions of acids and bases.
3. Estimation of sodium carbonate by titrating with hydrochloric acid.
4. Preparation of standard solution of EDTA.
5. Estimation of magnesium using EDTA.
6. Use of pH meter: determination of pH of given dilute solutions of shampoos and soaps
7. Titration of acid-base using pH meter.
8. Preparation of buffers.

1. Seamus P.J. Higson: Analytical Chemistry.
2. Douglas A. Skoog and Donald M..West: Fundamentals of Analytical Chemistry.
3. Adion A. Gordus: Schaum's Outline of Analytical Chemistry, Tata McGraw-Hill.
4. Gary D. Christian : Analytical Chemistry .
5. Freifelder and Kealy: Analytical Chemistry .
6. Daniel C Harris: Exploring Chemical Analysis.
7. Daniel C Harris: Quantitative Chemical Analysis.

PAPER-4

ENPT- 101: TECHNICAL WRITING AND COMMUNICATION IN ENGLSH

Unit 1

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit 2

Writing Skills; Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit 3

Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

SUGGESTED READINGS

1. M. Frank. Writing as thinking: *A guided process approach, Englewood Cliffs,* Prentice Hall Reagents.
2. L. Hamp-Lyons and B. Heasely: Study Writing; *A course in written English.* For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: *A comprehensive grammar of the English language*, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: *"Technical Report Writing Today"* - Biztaantra.

Additional Reference Books

5. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition (2004).
6. *Contemporary Business Communication*, Scot Ober, Biztantra, 5th Edition (2004).

PAPER-4

CSPT-101 - COMPUTATIONAL SKILLS

Computer Fundamentals (12 Periods)

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers

Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices

User Interface with the Operating System, System Tools

Data Representation (8 Periods)

Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of binary numbers, BCD, ASCII, Unicode;

Networks terminology (4 Periods)

Types of networks, router, switch, server-client architecture

Multimedia (4 Periods)

Introduction, Characteristics, Elements, Applications

Problem Solving (10 Periods)

Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

General Awareness (4 Periods)

IT Act, System Security (virus/firewall etc.)? *I-Tax, Reservations, Banking?*

SUGGESTED READINGS :

[1] V. Rajaraman, **Fundamentals of Computers,** Fourth Edition, PHI.

[2] Anita Goel, **Fundamentals of Computers;** Forthcoming title in Pearson-Education.

Note: Use of Open Office/Star Offices recommended, as they are freely downloadable.

Reference manual for Open Office available at: http://www.openffice.org

COMPUTATIONAL SKILLS

1. Defined projects will be done by the students and evaluated by the instructor.

2. Document Preparation.

3. Presentation Software.

4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting.

5. Spreadsheet Handling, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.

SEMESTER II

PAPER-5

CHPT-202: CHEMISTRY-2 (THERMODYNAMICS, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY-1)

Section A: Physical Chemistry-1   **(30 Lectures)**

Unit 1 Chemical Thermodynamics

What is thermodynamics? State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, thermodynamic properties, various types of systems and processes. First Law of thermodynamics.

Calculation of work (w), heat (q), changes in internal energy (ΔU) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w, q, ΔU and ΔH for processes involving changes in physical states.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature ó Kirchhofføs equation.

Various statements of Second Law of thermodynamics, concept of entropy. Gibbs free energy and Helmholtz energy, calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity, Gibbs ó Helmholtz equation. Maxwelløs relations.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit 2. Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelierøs principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.

olytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts ó applications of solubility product principle.

Section B: Organic Chemistry-2   (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Unit 4. Aromatic hydrocarbons
Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions : (Case benzene) : Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craftøs reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Unit 5. Alkyl and Aryl Halides
Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN_1, SN_2 and SN_i) reactions.   *Preparation:* from alkenes *and* alcohols.
Reactions: hydrolysis, nitrite & nitro formation, nitrile & iso-nitrile formation. Williamsonøs ether synthesis: Elimination vs substitution.
Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by ó OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).
Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit 6. Alcohols, Phenols and Ethers (Upto 5 Carbons)
Alcohols: *Preparation:* Preparation of 1 , 2 and 3 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation
Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

on: Cumene hydroperoxide method, from ...ophilic substitution: Nitration, halogenation and sulphonation. Reimer - Tiemann Reaction, Gattermann-Koch Reaction, Houben – Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Unit 7. Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde , acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro′s reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

SUGGESTED READINGS

1. T. W. Graham Solomons : *Organic Chemistry, John Wiley and Sons*.
2. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
3. I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
5. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
6. G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
7. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend:
   General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
10. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
11. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice Hall.
12. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
13. B.D.Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

CAL CHEMISTRY

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.

2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

3. Determination of enthalpy of ionization of acetic acid.

4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).

5. Determination of enthalpy of hydration of copper sulphate.

6. Study of the solubility of benzoic acid in water and determination of ΔH.

Section B: Organic Chemistry

1) Purification of organic compounds by crystallization (from water and alcohol) and distillation.

2) Criteria of Purity: Determination of melting and boiling points.

3) Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

   (a) Bromination of Phenol/Aniline

   (b) Benzoylation of amines/phenols

   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

PAPER-6

MAPT- 101: CALCULUS AND MATRICES

Unit I MATRICES (20 L)

R1, R2, R3 as vector spaces over R. Standard basis for each of them. Concept of Linar Independence and examples of different bases. Subspaces of R2, R3, Translation, Dilation, Rotation, Reflection in a point, line and plane, matrix form a basic geometric transformations. Interpretation of eigenvalues and eigen vectors for such transformations and eigen spaces as invariant subspaces. Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of Matrix. Solutions of a system of linar equations using matrices. Illustrative examples of above concepts from Geometry. Physics, Chemistry. Combinations and Statistics.

Unit II. CALCULUS (34 L)

Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance the sequence arising from Tower of Hanoi game, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Convergence of a sequence and algebra or convergent sequences, Illustration of proof of convergence of some simple sequences such as $(-1)n/n$, $l/n2$, $(1+1/n)n$, $\sin n/n$, xn with y I. Graphs of simple concrete functions such as polynomial, trigonometric, inverse trigonometric, exponential, logarithmic and hyperbolic functions arising in problems or chemical reaction, simple pendulum, radioactive decay temperature cooling/heating problem and biological rhythms, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivative. Function of two variables, Graphs and Level Curves of functions of two variables. Partial differentiation upto second order. Computation of Taylorøs Maclaurinøs series of functions such as e^x. Log $(1+x)$, $\sin (2x)$, $\cos x$, their use in polynomial approximation and error estimation, Formation and solution of differential equations arising in population growth. Radioactive decay, administration of medicine and cell division.

Geometrical representation of addition, subtraction, multiplication and division of complex numbers, Lines, half planes, circles, discs in terms of complex variables. Statement of the Fundamental Theorem of Algebra and its consequences, De Moivre's theorem for rational indices and its simple applications.

Suggested Readings:

1. George B. Thomas JR., Ross L.Finney: Calculus and Analytic Geometry, Pearson Education (Singapore) (2001).
2. T.M Apostal: Calculus, Vol, 1, John Wiley and Sons (Asia) (2002).
3. A.L. Kostrikin: Introduction to Algebra. Springer Verlag (1984).

Using computer aided software for example. Matlab/ Mathematica/ Maple/ MuPad/ wxMaxima for operations of complex numbers. Plotting of complex numbers matrices. Operations of matrices, determinant, rank, eigenvalue, eigenvector, inverse of a matrix, solution of system of equations.

PAPER-7

ACPT-202: ANALYTICAL CHEMISTRY-2: SEPARATION METHODS - I

I. CHROMATOGRAPHY:

A. Classification of chromatographic methods: Principle of differential migration, description of the chromatographic process, distribution coefficients, modes of chromatography, performing column chromatography.

B. Chromatography ó theory and practice: Introduction, the chromatograph (elution time and volume), capacity factor, column efficiency and resolution, sample preparation

C. Techniques of paper chromatography: experimental modifications, various modes of development, nature of the paper, detection of spots, retardation factors, factors that affect the reproducibility of Rf values (due to paper, solvent system, sample, development procedure), selection of solvent, quantitative analysis. applications

D. Thin layer chromatography: stationary phase, adsorbents, liquid phase supports, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, Rf values (effect of adsorbent, solvent, solute, development process), quantitative analysis, applications

II. SOLVENT EXTRACTION:
Distribution law, Determination of distribution ratio
Batch extraction, continuous extraction, discontinuous extraction, counter current extraction

L ANALYTICAL CHEMISTRY

1. Determination of Rf value of amino acids using paper chromatography.
2. Separation and identification of monosaccharides present in a given mixture by paper chromatography.
3. Determination of equivalent conductance of a weak electrolyte (acetic acid) at different concentrations.

4. Analysis of soil
 i) Determination of pH of soil.
ii) Determination of total soluble salts.
iii) Determination of carbonate and bicarbonate.
iv) Determination of calcium, magnesium and iron.

5. Determination of adulterant in some common food items
i) Chicory in coffee powder
ii) Foreign resin in asafetida
iii) Chilli powder
iv) Turmeric powder
v) Pulses

Suggested Readings:

1. F.W. Fifield and D. Kealy : Analytical Chemistry.
2. Daniel C Harris: Exploring chemical analysis.
3. Daniel C Harris: Quantitative chemical analysis.
4. R.V. Dilts Analytical Chemistry- Methods of Separation.
5. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

PAPER-8

ENPT-101: TECHNICAL WRITING AND COMMUNICATION IN ENGLSH

Unit 1
Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit 2
Writing Skills; Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit 3
Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

SUGGESTED READINGS
1. M. Frank. Writing as thinking: *A guided process approach, Englewood Cliffs,* Prentice Hall Reagents.
2. L. Hamp-Lyons and B. Heasely: Study Writing; *A course in written English.* For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: *A comprehensive grammar of the English language*, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: *"Technical Report Writing Today"* - Biztaantra.

Additional Reference Books

5. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition (2004).
6. Scot Ober *Contemporary Business Communication*, Biztantra, 5th Edition (2004).

PAPER-8

CSPT-101:   COMPUTATIONAL SKILLS

Computer Fundamentals (12 Periods)

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers;

Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices;

User Interface with the Operating System, System Tools.

Data Representation (8 Periods)

Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of binary numbers, BCD, ASCII, Unicode;

Networks terminology (4 Periods)

Types of networks, router, switch, server-client architecture.

Multimedia (4 Periods)

Introduction, Characteristics, Elements, Applications.

Problem Solving (10 Periods)

Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet.

General Awareness (4 Periods)

IT Act, System Security (virus/firewall etc.)? *I-Tax, Reservations, Banking?*

SUGGESTED READINGS :

 [1] V. Rajaraman, **Fundamentals of Computers,** Fourth Edition, PHI.

[2] Anita Goel, **Fundamentals of Computers;** Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.

Reference manual for Open Office available at: http://www.openffice.org

LS COMPUTATIONAL SKILLS

1. Defined projects will be done by the students and evaluated by the instructor.

2. Document Preparation

3. Presentation Software

4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting

5. Spreadsheet Handing, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.

SEMESTER III

PAPER-9

CHPT-303: CHEMISTRY-3 (SOLUTIONS, CONDUCTANCE, ELECTROCHEMISTRY AND FUNCTIONAL GROUP CHEMISTRY-2)

Section A: Physical Chemistry-2   **(30 Lectures)**

Unit 1 Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law ó non-ideal solutions. Vapor pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Unit 2 Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius ó Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

Unit 3 Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit 4 Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell,

perties: G, H and S from EMF data. nt from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry-3   (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Unit 5 Carboxylic acids and their derivatives
Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of Esters.
Reactions: Hell ó Vohlard - Zelinsky Reaction.
Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter-conversion.
Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Unit 6 Active methylene compounds:
Preparation: Claisen ester condensation. Keto-enol tautomerism.
Reactions: Synthetic uses of ethylacetoacetate (preparation of non-hetero molecules having upto 6 carbon).

Unit 7 Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)
Preparation: from alkyl halides, Gabrieløs Phthalimide synthesis, Hofmann Bromamide reaction.
Reactions: Hofmann Vs Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten ó Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.
Diazonium salts: *Preparation:* from aromatic amines.
Reactions: conversion to benzene, phenol, dyes.
Unit 8. Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of

uration of Glucose and Fructose, Mutarotation, osaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

SUGGESTED READINGS

1. G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Ed. Narosa (2004).
3. J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. B. H. Mahan: *University Chemistry*, 3rd Edn. Narosa (1998).
5. R. H. Petrucci, *General Chemistry*, 5th Edn., Macmillan Publishing Co.: New York (1985).
6. T. W. Graham Solomonøs: *Organic Chemistry,* John Wiley and Sons.
7. R. T. Morrison & R. N. Boyd: *Organic Chemistry,* Prentice Hall.
8. I. L. Finar: *Organic Chemistry (Vol. I & II),* E. L. B. S.
9. Jerry March: *Advanced organic Chemistry,* John Wiley & Sons.
10. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
11. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
12. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
13. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman, 1960.
14. B.D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.

CHPP-303: PRACTICAL CHEMISTRY

Section A: Physical Chemistry

1. pH measurements
   a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
   b) Preparation of buffer solutions:
        (i) Sodium acetate-acetic acid
        (ii) Ammonium chloride-ammonium hydroxide
        Measurement of the pH of buffer solutions and comparison of the

al values.

Study of the equilibrium of one of the following reactions by the distribution method:

$$I_2 (aq) + I^- (aq) \rightarrow I_3^- (aq)$$

$$Cu^{2+} (aq) + x\, NH_3(aq) \rightarrow [Cu(NH_3)_x]^{2+}$$
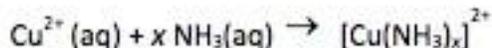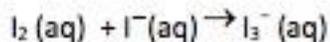
Section B: Organic Chemistry

Preparations: Mechanism of various reactions involved to be discussed.

Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Nitration of Nitrobenzene

(b) Preparation of carboxylic acid by alkaline hydrolysis of ester/amide.

(c) Oxidation of alcohol/aldehydes/hydrocarbons to carboxylic acid

(d) Osazone from glucose/fructose

(e) Amides and anilides from carboxylic acid.

(f) Preparation of methyl orange.

PAPER-10

MAPT-303: ALGEBRA

Groups: Definition and examples of groups, examples of abelian and non-abelian groups: the group Zn of integers under addition modulo n and the groups U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n, R), groups of symmetries of (i) iso equilateral triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation groups Sym (n), Group of quaternion. Subgroups, cyclic subgroups, the subgroups generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group, Cosets, Index of subgroup, Lagrange's theorem, order of an element. Normal subgroups: their definition, and characterization. Quotient groups.

Rings: Definition and examples of rings, examples of commutative and noncommutative rings; rings from number systems, Z_n the ring of integers modulo n ring of real quaternion rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of field. Z , Q, R and C field of radial functions.

Vector spaces: Definition and examples of vector spaces. Subspaces and its properties, Linear independence, basis, invariance of basis size dimension of vector space.

Linear Transformations on real and complex vector spaces: definition, examples, kernel, range, rank, nullity, isomorphism theorems, invertible linear transformations (characterizations). Algebra of Linear transformations and matrix of a linear transformation Linear functional over real & vector spaces - definition and examples.
Use of computer aided software for example, Matlab/ Mathematica/ Maple/ MuPad/ wxMaxima in Linear Transformations, group of symmetries, rectangle, square and permutation groups.

1. Joseph A Gallian: *Contemporary Abstract Algebra,* 4th Edn., Narosa (1999).
2. George E. Andrews: *Number Theory,* Hindustan Publishing Corporation (1984).
3. C.W. Curtis, *Linear Algebra, an introductory approach,* Springer-Verlag (1991).
4. David M. Blotin, *Linear algebra and Geometry,* Cambridge Press (1979).

PAPER-11

ACPT-303: ANALYTICAL CHEMISTRY-3: QUANTITATIVE METHODS OF ANALYSIS

I. GRAVIMETRIC ANALYSIS:

A. Precipitation methods

B. Volatilization methods. (The analyte or its decomposition products are volatilized at a suitable temperature. The volatile product is then collected and weighed, or, alternatively, the mass of the product is determined indirectly from the loss in mass of the sample. E.g., determination of the sodium hydrogen carbonates content of antacid tablets)

C. Properties of precipitates and precipitating reagents:

- Particle size, Filterability of Precipitates (factors that determine particle size, formation of precipitates and particle size).
- Colloidal Precipitates (coagulation of colloids, peptization of colloids, treatment of colloidal precipitates).
- Crystalline Precipitates (particle size and filterability).
- Co-precipitation (surface adsorption, mixed-crystal formation, occlusion, and mechanical entrapment, co precipitation errors).
- Precipitation from Homogeneous Solution (The use of the technique of homogeneous solutions to effect precipitation).

D. Drying and Ignition of precipitates

E. Practical gravimetric procedures.

II. VOLUMETRIC ANALYSIS

A. Definitions: Titrimetry, Volumetric titrimetry, Gravimetric titrimetry, Coulometric titrimetry.

The equivalence point, the end point

- Classification of volumetric methods, theory of indicators and buffers.
- Equilibria
- Principles
- Aqueous and non-aqueous acid-base titration.
- Redox titrations
- Complexometric titrations
- Precipitation titrations

C. Typical problems in volumetric titrimetry:
 D. Sigmoidal Titration Curves
 E. The Henderson-Hasselbalch Equation.

III. CENTRIFUGATION METHODS:
 A. Introduction
 B. Sedimentation and relative centrifugal force
 C. Different types of rotors.
 D. Density gradient
 E. Types of centrifugation techniques.

IV. INTRODUCTION TO ENVIRONMENTAL ANALYSIS:
 A. Sampling method
 B. Environmental pollution from industrial effluents and radiochemical waste.
 C. Introduction to water and waste analysis.

ACPP- 303: PRACTICAL ANALYTICAL CHEMISTRY

1. Determination of the pKa and Equivalent Weight of a weak acid by potentiometric pH titration.
2. Determination of the strength of the given magnesium sulphate solution using EDTA and Eriochrome black óT as the indicator.
3. Determination of the capacity of an anionic exchange resin.
4. Separation of cadmium and zinc on an ion exchange resin.
5. Homogeneous precipitation of the Nickel as its Dimethylglyoxime.
6. Determination of the formula and stability constant of the chelate formed between so iron (III) and salicylic acid.
7. Determination of the formula and stability constant of the chelate formed between so iron (III) and Tiron.

Suggested Readings:

1. Analytical Chemistry- Methods of Separation (R.V. Dilts).
2. Laboratory Handbook of Chromatographic Methods (O. Mikes, R.A. Chalmers).
3. F.W. Fifield and D. Kealy: Analytical Chemistry.
4. Vogel's textbook of quantitative chemical analysis, 6th edition.
5. Vogel's textbook of quantitative chemical analysis, 7th edition.
6. Keith Wilson and John Walker : Practical Biochemistry.

PAPER 602: BIOCHEMISTRY AND ENVIRONMENTAL CHEMISTRY

Unit I:

- Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
- Proteins: classification, biological importance; Primary and secondary and tertiary structures of proteins: -helix and - pleated sheets, Denaturation of proteins.
- Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in õGreen Chemistryö and Chemical Industry.

Unit II:

- Lipids: Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.
- Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

Unit III:

- Environment and itøs segments, Ecosystems, Biogeochemical cycles of carbon, nitrogen and sulphur.
- Air Pollution: Major regions of atmosphere, Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical Smog: its constituents and photochemistry, Environmental effects of Ozone, Major sources of Air pollution.
- Effects of air pollution on living organisms and vegetation, Controls of air pollution, Climate change, Green house effect, global warming. Techniques of measuring air pollutants.

...ical cycle, water resources, aquatic ecosystems, ...ter pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods.

Unit IV:
- Energy and Enviornment: Sources of energy: Coal, petrol and Natural gas. Nuclear Fusion / Fisson, Solar energy, Hydrogen, geothermal, Tidal and Hydel etc.
- Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and itøs management.

Recommended Texts:
1. J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry, 6th Edn. W.H. Freeman and Co. (2006).
2. D.L. Nelson, M.M. Cox, and A.L. Lehninger, Principles of Biochemistry. IV Edition. W.H. Freeman and Co. (2009).
3. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, Harperøs Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill (2009).
4. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
5. G.T. Miller, Environmental Science 11th edition. Brooks/Cole (2006).
6. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

PAPER 602: PRACTICAL BIOCHEMISTRY AND ENVIRONMENTAL CHEMISTRY

1. To perform quantitative estimation of protein using Lowryøs method. Determine the concentration of the unknown sample using the standard curve plotted.
2. Study of the action of salivary amylase at optimum conditions.
3. Effect of pH on the action of salivary amylase.
4. Effect of temperature on the action of salivary amylase.
5. Effect of inhibitor on the action of salivary amylase.

...psin using fresh tissue extracts.

...erature, organic solvents, on semi-permeable membrane.

8. Isolation of Genomic DNA from E. Coli.
9. Qualitative analysis of the soil from different locations for pH and different water soluble cations and anions.
10. Quantitative estimation of oxidisable organic matter in soil, carbonate and bicarbonates by volumetry and calcium and magnesium by EDTA titration.
11. Hardness of water by EDTA titration.
12. Study of pH and conductivity of tap water and polluted water.

SEMESTER IV

PAPER-13

CHPT-404: CHEMISTRY-4 (CHEMISTRY OF s & p BLOCK ELEMENTS, STATES OF MATTER AND PHASE EQUILIBRIUM)

Section A: Inorganic Chemistry-2   **(30 Lectures)**

Unit 1 General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mondøs process.

Unit 2 *s*- and *p*- Block Elements

Periodicity in s- and p- block elements w.r.t. electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mullikan, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Unit 3 Compounds of *s*- and *p*- Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.

Concept of multicentre bonding (diborane).

Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH)

Oxoacids of P, S and Cl.

Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

Section B: Physical Chemistry-3   **(30 Lectures)**

Unit 1 Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Vander Waals equation of state for real gases. Boyle temperature

phenomena, critical constants and their

quation. Andrews isotherms of CO_2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation ó derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Unit 2 Liquids
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Unit 3 Solids
Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. XóRay diffraction by crystals, Braggøs law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Unit 4 Chemical Kinetics
The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Halfólife of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.
Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

SUGGESTED READINGS
1.   G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
2.   G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
3.   J. C. Kotz, P. M. Treichel & J. R. Townsend:
     General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
4.   B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).

mistry 5th Ed. Macmillan Publishing Co.: New

6. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
7. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
8. D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
10. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
11. A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
12. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

CHPP-404: PRACTICAL CHEMISTRY

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H_2S of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH_4^+, Pb^{2+}, Ag^+, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+

Anions : CO_3^{2-}, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-

(Spot tests should be carried out wherever feasible)

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded).

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Phase equilibria

a) Construction of the phase diagram of a binary system (simple

curves.

tical solution temperature and composition of the phenol water system and study of the effect of impurities on it.

c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

PAPER-14

PHPT-303: PHYSICS -2: WAVE AND OPTICS

Oscillations and Waves (Total Number of Lectures = 30)

Simple Harmonic Motion: Simple Harmonic Oscillator, Motion of simple and compound pendulum, Loaded spring, Energy in simple harmonic motion, Superposition of two SHM: (i) collinear SHM cf same frequency (ii) collinear SHM of different frequencies ó phenomenon of Beats (iii) SHM of same frequency but perpendicular to each other and (iv) Lissajous figures.

Damped Harmonic Motion: Equation of motion, Dead beat motion, Critically damped system, Lightly damped system: relaxation time, logarithmic decrement, qualify factor.

Forced Oscillations: Equation of motion, complete solution, Steady state solution, Resonance, Sharpness of resonance, Quality factor.

Couples Oscillator: Degrees of freedom, Couples oscillatory with two degrees of freedom; Normal modes; General method of finding normal modes for a system of two degrees of freedom.

Wave Motion: One dimensional plane wave, Classical wave equation, Superposition principle, Standing wave on a stretched string (both ends fixed).

Wave Optics (Total Number of Lectures = 30)

Interference: Essential conditions for observing interference; Division of wave front: Youngøs double slit experiment, colour of thin films, Division of amplitude: Newton rings.

Diffraction: Fresnel and Fraunhofer diffraction, Fraunhofer Diffraction ó single slit (intensity distribution, position of maxima and minima), circular aperture (qualitative), plan diffraction grating, resolving power of grating, Rayleighøs

lf period zone, rectilinear propagation of light,

Polarization: Polarization of light (plane polarized light), Double refraction, Law of Malus, Nicol Prism, Polarizing materials, Polarizer, Analyzer, Light propagation in anoxia crystals.

REFERENCES

1. Francis Arthur Jenkins and Heavy Elliott White: Fundamentals of optics, Tata Mc-Graw Hill (1976).
2. Ajoy Ghatak: Optics, Tata McGraw Hill (2008).
3. A.K. Ghatak & K. Thyagarajan: Contemporary optics, Plenum Press (1978).
4. Khanna and Gulati: Introduction to Optics.
5. N.K. Bajaj: The physics of waves and oscillations,Tata Mc-Graw Hill (1988).
6. A.P. French: Vibrations and Waves, CBS Pub. & Dist. (1987).
7. B.K. Mathu: Optics.

PHYSICS

1. To determine the Coefficient of Thermal Conductivity of Copper by Searle's apparatus.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the Temperature Coefficient of Resistance ( ) by Platinum Resistance Thermometer (PRT). Assume R_____.
4. To draw a calibration curve for a Thermocouple using a Potentiometer.
5. To determine Stefan's Constant.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light suing Newton's rings.
8. To determine the Cauchy's constant and dispersive power of a prism using mercury light.
9. To determine the wavelength of Sodium light using plane diffraction grating.
10. To study the polarization of light by the reflection and to determine the polarizing angle for air-glass interface.

Suggested Books for Reference

1. B.L. Worsnop and H.T. Flint: Advanced Practical Physics, Asia Publishing House, New Delhi.
2. Indu Prakash and Ramakrishna: A Text Book of Practical Physics, Kitab Mahal, New Delhi.
3. Nelson and Jon Ogborn: Practical Physics.

PAPER-15

ACPT-404: ANALYTICAL CHEMISTRY-4: SEPARATION METHODS - II

I. COLUMN CHROMATOGRAPHY.

A. General: columns, matrix materials, stationary phase, column packing, application of sample, column development and sample elution, detectors and fraction collectors, applications.

B. High performance liquid chromatography: Principle, column, matrices and stationary phases, column packing, mobile phase and pumps, application of sample, detectors, applications.

C. Adsorption chromatography: Principle, adsorbents, solvents, nature of solute, operating parameters, retention volumes and times, applications.

D. Liquid-liquid partition, chromatography: Principle, normal phase chromatography, reversed- phase liquid chromatography, reversed phase liquid chromatography, applications.

E. Ion- exchange chromatography: Principle, ion exchangers, ion- exchange equilibria, ion- exchange resin selectivity, column operations (column development, detection of solute bands), factors affecting retention volumes, applications.

F. Gel chromatography: Principle, types of gels, separation by gel chromatography, applications.

G. Affinity chromatography: Principle, materials, selection and attachment of ligand, practical procedure, applications,

H. Gas- liquid chromatography: Apparatus and materials, preparation and application of samples, separation conditions, detectors, applications.

II. ELECTROPHORETIC TECHNIQUES:

A. Principle, apparatus, support media (paper, cellulose acetate membranes, gels).

B. SDS-PAGE, native gels, gradient gels, isoelectric focusing, 2D-PAGE, continuous flow electrophoresis, detection, estimation and recovery of proteins in gels.

...sis of nucleic acids, capillary electrophoresis.

D. Isoelectric Focusing

III. DIALYSIS AND MEMBRANE FILTRATION

A. Filters- nitrocellulose, fiberglass, polycarbonate

B. General laboratory methods.

IV. CENTRIFUGATION METHODS: Introduction, sedimentation and relative centrifugal force, different types of rotors, density gradients, types of centrifugation techniques.

V. RADIOISOTOPIC TECHNIQUES: nature of radioactivity. Detection and measurement of radioactivity, inherent advantages and restrictions of radiotracer experiments, safety aspects

L ANALYTICAL CHEMISTRY

1. Determination of the strength of the given HCl solution by titrating it against NaOH solution conductometrically.

2. Separation of a mixture of Ni^{2+} and Cu^{2+} by TLC and identify the ions.

3. Determination of residual chlorine in city water supply using colorimetry.

4. Determination of adsorption isotherm of acetic acid on activated charcoal. Determination of the adsorption constant (k)

5. Determination of nicotine content in cigarette tobacco.

Suggested Readings :

1. R.V.Dilts: Analytical Chemistry- Methods of Separation.
2. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.
3. F.W. Fifield and D.Kealy: Principles and practice of analytical chemistry.
4. Vogel's textbook of quantitative chemical analysis, 6th edition.
5. Vogel's textbook of quantitative chemical analysis, 7th edition.
6. Keith Wilson and John Walker: Practical Biochemistry.
7. David J.Holme and Hazel Peck: Analytical Biochemistry.
8. David Freifelder: Physical Biochemistry.

PAPER-16

EL 310 (vi) INTELLECTUAL PROPERTY RIGHTS (IPR)

In this era of liberalization and globalization, the perception about science and its practices have undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels ó statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.

Unit I **Introduction to Intellectual Property**
Historical Perspective, Different Types of IP, Importance of protecting IP.

Unit II **Copyrights**
Introduction, How to obtain, Differences from Patents.

Unit III **Trade Marks**
Introduction, How to obtain, Different types of marks ó Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Unit IV **Patents**
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare ó balancing promoting innovation with public health, Software patents and their importance for India.

Unit V **Geographical Indications**
Definition, rules for registration, prevention of illegal exploitation, importance to India.

Unit VI **Industrial Designs**
Definition, How to obtain, features, International design registration.

egrated circuits
rated Chips, Importance for electronic industry.

Unit VIII **Trade Secrets**
Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Unit IX **Different International agreements**
(a) **Word Trade Organization (WTO):**
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty
(b) **Paris Convention**

Unit X **WIPO** and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity

Unit XI **IP Infringement issue and enforcement** ó Role of Judiciary, Role of law enforcement agencies ó Police, Customs etc. Economic Value of Intellectual Property ó Intangible assets and their valuation, Intellectual Property in the Indian Context ó Various laws in India Licensing and technology transfer.

Suggested Readings

1. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
2. Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell,* West Group Publishers (2000).
5. Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

SEMESTER V

PAPER-17

CHPT-505: CHEMISTRY-5 (CHEMISTRY OF d-BLOCK ELEMENTS, QUANTUM CHEMISTRY AND SPECTROSCOPY)

Section A: Inorganic Chemistry-3   **(30 Lectures)**
Unit 1 Transition Elements (3d series)
General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.
Lanthanides and actinides: Electronic configurations, Oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit 2 Coordination Chemistry
Valency Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.
Drawbacks of VBT. IUPAC system of Nomenclature.

Unit 3. Crystal Field Theory
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Section B: Physical Chemistry-4   **(30 Lectures)**
Unit 4. Quantum Chemistry & Spectroscopy
Spectroscopy and its importance in chemistry. Wave-particle duality. Link between spectroscopy and quantum chemistry. Electromagnetic radiation and its interaction with matter. Types of spectroscopy. Difference between atomic and molecular spectra. Born-Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.
Postulates of quantum mechanics, quantum mechanical operators.
Free particle. Particle in a 1-D box (complete solution), quantization, normalization

-point energy.

quation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels. Microwave (pure rotational) spectra of diatomic molecules. Selection rules. Structural information derived from rotational spectroscopy.

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels. Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra. Vibrations of polyatomic molecules. Group frequencies. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free Electron model and its application to electronic spectra of polyenes. Colour and constitution, chromophores, auxochromes, bathochromic and hypsochromic shifts.

Unit 5. Photochemistry

Laws of photochemistry. Lambert-Beerøs law. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions. Photoelectric cells.

SUGGESTED READINGS

1. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
5. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
7. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
8. D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
10. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
11. A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
12. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

L CHEMISTRY

Section A: Inorganic Chemistry

1. Estimation of the amount of nickel present in a given solution as Bis(dimethylglyoximato) nickel(II) or aluminium as oxinate in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.
4. To draw calibration curve (absorbance at $_{max}$ vs. concentration) for various concentrations of a given coloured compound and estimate the concentration of the same in a given solution.
5. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} - phenanthroline complex in solution by Job's method.
6. Determination of concentration of Na^+ and K^+ using Flame Photometry.

Section B: Physical Chemistry

(I) Potentiometric measurements
   (a) Strong acid with strong base
   (b) Weak acid with strong base
   (c) Mohr's salt with potassium dichromate
(II) Conductometric measurements.
   (a) Determination of the cell constant.
   (b) Study of the variation of molar conductivity of a strong electrolyte (KCl) and of a weak electrolyte (acetic acid) with concentration.
   (c) Conductometric titrations for the following systems :
      (i) strong acid - strong base (ii) weak acid - strong base
(III) Kinetic studies
   Study of the kinetics of the following reactions by integrated rate method:
   a) Acid hydrolysis of methyl acetate with hydrochloric acid, volumetrically or conductometrically.
   b) Iodide-persulphate reaction.

PAPER-18

PHPT-404: PHYSICS-3: ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Electrostatics (Number of Lectures = 15)

Electric field: - Concept of electric field lines and electric flux. Gauss's law (Integral and differential forms), application to linear, Plane and spherical charge distributions, Conservative nature of electric field E, irrotational field.

Electric Potential: Concept of electric potential, relation between electric potential and electric field, potential energy of a system of charges, energy density in an electric field Calculation of potential from electric field for a spherical charge distribution.

Magnetostatics (Number of Lectures = 20)

Concept of magnetic field B and magnetic flux, Biot-Savart's law, B due to a straight current carrying conductor, Force on a point charge in a magnetic field. Properties of B cur and divergence of B, solenoidal field.

Integral form of Ampere's law, applications of Ampere's law: field due to straight, circular and solenoidal currents. Energy stored in magnetic field, Magnetic Energy in terms to current and inductance. Magnetic force between two current carrying conductors. Magnetic field intensity.

Ballistic Galvanometer: - Torque on a current loop in a uniform magnetic field, working principle of B.G., current and charge sensitivity, electromagnetic damping, critical damping resistance.

Electromagnetic Induction and electromagnetic Waves (Number of Lectures = 25)

Faraday's laws of induction (differential and integral form), Lenz's law, self and mutual induction.

...on of Ampere's law, displacement current, ...nd dielectric medium, boundary conditions, plane wave equation transverse nature of EM waves, velocity of light in vacuum and in medium, polarization, reflection and transmission.

Polarization of EM waves, Brewster's angle, description of linear, circular and elliptical polarization.

Suggested Books

1. Arthur F. Kip: Fundamentals of electricity and magnetism, McGraw-Hill (1968)
2. J.H. Fewkes & John Yarwood: Electricity and magnetism, Vol. 1, Oxford Univ. Press (1991).
3. David J. Griffiths: Introduction to Electrodynamics, 3rd Edn., Benjamin Cummings (1998).
4. Edward M. Purcell: Electricity and magnetism, McGraw-Hill Education (1986).
5. D.C. Tayal: Electricity and Magnetism, Himalaya Publishing House (1988).
6. Joseph A. Edminister: Electromagnetic, 2nd Edn., ata Mc Graw Hill (2006).

PHPP-404: PRACTICAL PHYSICS

1. To verify the Thevenin, Norton, Superposition, and maximum power transfer theorem.
2. To determine a low resistance by Carey foster's bridge.
3. To determine the (a) current sensitivity, (b) charge sensitivity and (c) CDR of a B.G.
4. To determine high resistance by leakage method.
5. To determine the ratio of two capacitances by De Sauty's bridge.
6. To determine self inductance of a coil by Anderson's bridge using AC.
7. To determine self inductance of a coil by Rayleigh's method.
8. To determine coefficient of Mutual inductance by absolute method.

Suggested books:

1. B.L. Worshop and H.T. Flint: Advanced Practical Physics, Asia Publishing House, New Delhi.
2. Indu Prakash and Ramakrishna: A Text Book of Practical Physics, Kitab Mahal, New Delhi.
3. Nelson and Jon Ogborn: Practical Physics.

PAPER-19

ACPT-505: ANALYTICAL CHEMISTRY-5: ANALYTICAL BIOCHEMISTRY

SECTION I:
A. BASIC UNDERSTANDING OF THE STRUCTURES, PROPERTIES AND FUNCTIONS OF CARBOHYDRATES, LIPIDS, AND PROTEINS

1. Isolation and characterization of polysaccharides.
2. Classification of lipids, properties, functions and Biochemical functions of steroid hormones.
3. Proteins- structure, classification, isolation, characterization and functions.
4. Biochemistry of peptide hormones.
5. Enzymes- nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.
6. Lipoproteins

B. SECTION II .BIOCHEMISTRY OF DISEASE: A DIAGNOSTIC APPROACH

Clinical chemistry: a diagnostic approach by blood/urine analysis.

1. Blood: Composition and functions of blood, blood coagulation.
2. Blood collection and preservation of samples.
3. Anemia
4. Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
5. Urine: Collection and preservation of samples.
6. Formation of urine.
7. Composition and estimation of constituents of normal and pathological urine.

L ANALYTICAL CHEMISTRY

Identification and estimation of the following:

1. Carbohydrates ó qualitative and quantitative.
2. Lipids ó qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins ó qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Suggested Readings:

1. T.G.Cooper: Tool of Biochemistry.
2. Keith Wilson and John Walker: Practical Biochemistry.
3. Alan H Gowenlock: Varleyøs Practical Clinical Biochemistry.
4. Thomas M. Devlin: Textbook of Biochemistry.
5. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
6. G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
7. A.L.Lehninger: Biochemistry.
8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

PAPER-20

Elective-1: Any one out of

EL 310 (I) GREEN CHEMISTRY
EL 310 (II) POLYMER SCIENCE
EL 310 (III) BIOTECHNOLOGY
EL 310 (IV) FORENSIC SCIENCE

EL 310 (i) GREEN CHEMISTRY

With the environmental concern and shrinking resources acquiring enormous proportions, it has become imperative to devise safer alternative materials and technology that would ensure the human sustenance. This course intends to take the students through the newer, environment friendly products and procedures and incite them to take a more holistic view of different chemical processes.

Unit l   **Introduction to Green Chemistry**
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Unit II   **Principles of Green Chemistry and Designing a Chemical synthesis**
Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals ó different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization ó careful use of blocking/protecting

tic reagents (wherever possible) in preference to ...ents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit III   **Examples of Green Synthesis/Reactions**

1 Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to strecker synthesis), citral, ibuprofen, paracetamol, turtural.

2 Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).
Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels Alder Reaction, Decarboxylation.
Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

3 Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

4 Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of õClayanö, a non-metallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in Organic Syntheses; Biocatalysis in Organic Syntheses.

Green Chemistry

...ts and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

Suggested Readings:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastes & J.K. Warmer: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Deckkar, (2001).
4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

EL 310 (ii) POLYMER SCIENCE

The Primary Objective of Polymer Science course is to prepare skillful Polymer Scientists to meet the growing requirements in polymer based industry, Government, research & development organizations and teaching institutions.

Unit I   Introduction and history of polymeric materials. Different Schemes of Classification of Polymers, Polymer nomenclature, Molecular forces and chemical Bonding in Polymers, Texture of Polymers.

Unit II   Functionality and its importance, Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

Unit III   Kinetics of Polymerization: Mechanism and Kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallinity, Determination of Crystalline melting point and degree of Crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Unit V   Nature and structure of polymers-Structure Property relationships. Determination of molecular weight of polymers (Mn, Mw, etc), by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Unit VI   Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Unit VII   Polymer Solution ó Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory-Huggins theory, Lower and Upper critical solution temperatures.

Unit VIII   Properties of Polymer (Physical, thermal, Flow & Mechanical Properties).

Unit IX   Brief introduction to preparation, structure, properties and application of the following polymers, Polyolefins, Polystyrene and styrene copolymers, Poly (vinyl chloride) and related polymers, Poly (vinyl acetate) and related polymers, Acrylic polymers, Fluoro Polymers, Polyamides and related polymers. Phenol formaldehyde Resins (Bakelite, Novalac), Polyurethanes, Silicone Polymers, Polydienes, Polycarbonates, Conducting Polymers, [Polyacetylene, Polyaniline, Poly (p-phenylene sulphide Polypyrole, Polythiophene)].

Suggested Readings

1. *Seymour Polymer Chemistry,* Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeryer: Text Book of Polymer Science, John Wiley.
4. P.Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

EL 310 (iii) BIOTECHNOLOGY

The purpose of this course is to provide to the students of Science, a basic understanding of the principles, tools and techniques, and applications of the fast expanding fields of biotechnology. This would help the students to develop interactions/linkages with the industry and venture into Science entrepreneurship.

Unit I   **Biotechnology**
Scope and Applications, Overview of Tools and Techniques.

Unit I   **Industrial Microbiology**
Microbial resources for food, food additives, flavours, feed, single cell proteins, solvents, enzymes, organic acids, vitamins, pharmaceuticals, agrochemicals, bio-fertilizers. Waste decomposition and conversions, bio-fuels, Bioremediation, Recombinant proteins

Unit III   **Strain improvement**
Screening, selection, mutation, recombination, protoplast fusion, DNA technology.

Unit IV   **Fermentation**
Different types of fermentation ó submerged and solid state; batch, fed batch and continuous; product-based ó enzymes, alcohol, methane, acid, mixed acid and solvent. Types of fermenters-stirred tank, air lift, fixed bed and fluidized. Down stream processing ó filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.

Unit V   **Plant Biotechnology**
Plant tissue culture and somatic cell genetics and their applications in agriculture, plant transformation-vectors and methods, genetic engineering and transgenic plants with useful agronomic traits and products.

Unit VI   **Animal Biotechnology**

...duction of bio-products, gene manipulation and ...y, gene therapy, vaccines, hybridoma technology and immunodiagnostics.

Unit VII   Bio safety
Physical and Biological containment, environmental co-concerns.

Suggested Readings:

1. P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003).
2. B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
3. T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
4. M.K. Razdan: Introduction to plant tissue culture, Oxford & IBH, New Delhi (2003).
5. Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).

EL 310 (iv) FORENSIC SCIENCE

Forensic Science pertains to analysis and examination of Physical evidence recovered from a crime scene to legal proceedings. Examinations of fingerprint, toxic substances detection of blood and other biological fluids, as well as examination of skeletal material, hair fiber etc is performed to provide scientific opinion for legal.

Unit I   Definition, History, Development and Scope of Forensic Science. Divisions of Forensic Science and Laboratory Set up.

Unit II   Basic Principles, theory and application of spectroscopy (U.V., I.R., Atomic Absorption Emission and Mass) and its forensic applications.

Unit III   Electrophoresis (Immuno and Iso-electrofocusing) theory, principle and techniques. X-ray (Hard and Soft) techniques and their forensic applications.

Unit IV   Forensic Chemistry: Introduction, Conventional methods of chemical analysis, presumptive tests (colour & spot); Drugs of Abuse:

...sification; Forensic Toxicology: Introduction and ... chemical analysis for alcohol, Classification of poisons.

Unit V   Questioned documents: Definition, handwriting, characteristic, natural variation, comparison and forgery; Forensic photography ó techniques and important of photography.

Unit VI   Fingerprint Identification: History and development, biological basis of fingerprints, pattern types, scene of crime prints, methods of processing latent/fingerprints, ridge characteristics, comparison of fingerprints for establishing complete identity.

Unit VII   Tool marks: their identification and importance in forensic science; Trace evidence: Definition, identification and their importance in forensic science.

Unit VIII   Identification and detection of biological fluids (Blood, Semen, Saliva and Urine) and their Medico-logical importance.

Unit IX   Personal Identification through somatometry and Somatoscopy; Study and hair and fibers.

Unit X   Examination of skeletal remains-identification of bones, differentiation between human and non human, determination of age, sex and height from skeletal remains.

Unit XI   Modern Developments and their concepts (Nacre analysis, Brain fingerprinting, DNA Profiling, voice identification, Cyber crime, Forensic Odontology and Bitemarks).

Note;   Practical demonstrations are compulsory as without the demonstration the students would not be able to understand the value of the specific topics of Forensic Science.

Practical demonstration of procedure of taking fingerprints; identification of pattern types, developing latent fingerprints (Powder Method), spot test for blood identification, Somatoscopic observations, Age and Sex determination from skull, estimation of height from long bones, hair morphology, tests for fiber identification.

1. R. Saferstein: *Criminalistics,* Prentice Hall (1998).
2. B.R. Sharma: *Forensic Science in Criminal Investigation and Trials,* Central Law Agency, Allahabad (2003).
3. W.G. Eckert: *Introduction of Forensic Science,* CRE Press, Bock Raton (1997).
4. I.P. Singh and M.K. Bhasin: *A Laboratory Manual of Biological Anthropology,* K.R. Enterprises, N. Delhi (2005).
5. S. Nath: *An Introduction to Forensic Anthropology,* Gian Publishing House, N. Delhi (1989).
6. S. Nath: Personal Identification through Fingerprints, Shree Publisher & Distributors, New Delhi (2006).

SEMESTER VI

PAPER-21

CHPT-606: CHEMISTRY-6 (ORGANOMETALLICS, BIO-INORGANIC CHEMISTRY, PROTEINS AND UV-IR SPECTROSCOPY)

Section A: Inorganic Chemistry-4 (30 Lectures)

Unit 1 Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties);

Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Unit 2 Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, σ, π and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π - acceptorbehaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

Unit 3 Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Section B: Organic Chemistry-4 (30 Lectures)

Unit 1 Polynuclear and Heteronuclear aromatic compounds:

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole, Thiophene, and Pyridine.

Unit 2. Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitter ion, Isoelectric point and Electrophoresis.

óCOOH group, acetylation of óNH$_2$ group, ...ydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and Cóterminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Unit 3. Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α,β ó unsaturated compounds.

Infrared radiations and types of molecular vibrations, functional group and Finger print region. IR spectra of alkanes, alkenes and simple alcohols (inter and intra molecular Hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

SUGGESTED READINGS

1. James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.
2. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication.
3. J.D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
5. I. L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds,* Prentice Hall.
7. R.M. Silverstein, G.C. Bassler & T.C. Morrill: *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
8. R.T. Morrison & R.N. Boyd: *Organic Chemistry,* Prentice Hall.
9. Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry,* Orient Longman.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
11. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
12. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
13. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.

CHPP-606: PRACTICAL CHEMISTRY

Section A: Inorganic Chemistry

1.   Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)
     Paper chromatographic separation of Fe^{3+}, Al^{3+} and Cr^{3+}

                                        or

     Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}

2.   Preparation of any two of the following complexes and measurement of their conductivity:

(i) tetraamminecarbonatocobalt (III) nitrate

(ii) tetraamminecopper (II) sulphate

(iii) potassium trioxalatoferrate (III) trihydrate

Compare the conductance of the complexes with that of M/1000 solution of $NaCl$, $MgCl_2$ and $LiCl_3$.

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1° amines) and preparation of one derivative.

PAPER-22

MAPT – 404: DIFFERENTIAL EQUATIONS

First order exact differential equations, Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x y p dy dx. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian and its properties. Solving a differential equation by reducing its order. Linear homogenous equations with constant coefficients, Linear non-homogenous equations. The method of variation of parameters, The Cauchy- Euler equation, Simultaneous differential equations, total differential equations.

Applications of differential equations: the vibrations of a mass on a spring, mixture problem, free damped motion, forced motion, resonance phenomena, electric circuit problem, mechanics of simultaneous differential equations.

Partial differential Equations

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations. Formation of first order partial differential equations, linear partial differential equation of first order. Lagrange's method, Charpit's method. Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only. Applications to traffic flow.

Using Computer aided software for example, Matlab/ Mathmatica/ Maple/ MuPadeharaeteristics,vibrating string vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws.

Recommended Books

1. Shepley L. Ross: Differential equations, 3rd Edn., John Wiley and Sons (1984).
2. Sneddon: Elements of Partial differential equations, McGraw-Hill, International Edition (1967).

PAPER-23

ACPT-606: ANALYTICAL CHEMISTRY-6: INSTRUMENTAL METHODS OF ANALYSIS

I. **AN INTRODUCTION TO SPECTROSCOPIC METHOD OF ANALYSIS:**
   (RECAP of the introduction covered in detail in the chemistry syllabus)

II. **UV AND VISIBLE SPECTROPHOTOMETRY:**
   A. Lambert-Beer's law
   B. Principles, Instrumentation, Single/double beam instrument
   C. Applications

III. **IR SPECTROPHOTOMETRY**:
   A. Principle
   B. Instrumentation, applications

IV. **FLAME PHOTOMETRY**
   A. Principle
   B. Instrumentation
   C. Single/double beam instruments
   D. Experimental procedure
   E. Applications

V. **ATOMIC SPECTROSCOPY:**
   A. Types
   B. Atomizer
   C. Atomic absorption and emission
   D. Applications

VI. **NMR SPECTROSCOPY**:
   A. Principle
   B. Instrumentation
   C. Factors affecting chemical shift
   D. Spin-coupling
   E. Applications

L ANALYTICAL CHEMISTRY

1. Determination of the partition coefficient of iodine between carbon tetrachloride and water.
2. Determination of the pKa of an indicator.
3. Study of changes in conductance in the following systems.
4. i) Weak acid-strong base; ii) Strong acid-strong base.
5. To determine the isoelectric pH of a protein.
6. To draw the titration curve of an amino acid.
7. To determine the void volume of a gel filtration column.

Suggested Readings:

1. P.W.Atkins: Physical Chemistry.
2. G.W. Castellan: Physical Chemistry.
3. C.N.Banwell: Fundamentals of Molecular Spectroscopy.
4. Brian Smith: Infra red Spectral Interpretations: A Systematic Approach.
5. W.J.Moore: Physical Chemistry.

PAPER-24

Elective-2: Any one out of

EL 310 (I) GREEN CHEMISTRY
EL 310 (II) POLYMER SCIENCE
EL 310 (III) BIOTECHNOLOGY
EL 310 (IV) FORENSIC SCIENCE

which has been not opted in Semester 5