
SCHEME OF EXAMINATION
AND
COURSES OF READING
FOR
B.Sc. INDUSTRIAL CHEMISTRY



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

Industrial Chemistry

The course on B.Sc. Industrial Chemistry was introduced in the University of Delhi in 1984 and since then this course has undergone many changes and has become more comprehensive and relevant. The importance of industrial chemistry hardly needs any emphasis. It basically deals with the development, optimisation and monitoring of various chemical processes used in industry for transforming raw materials etc., into useful commercial products for society. Industrial chemistry as an applied science plays a vital role in diverse areas that influence human society.

The course in the present form focuses on industrial processes used in the production of major bulk chemicals and their secondary commercial products (dyes, pesticides, drugs, polymers etc.) besides covering the traditional areas of chemistry. In this three year course spread over six semesters, there are 12 papers of chemistry including 6 papers of industrial 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, namely, green chemistry, polymer science, biotechnology, forensic science.

It is hoped that the students will find this course very interesting as it will equip them for job opportunities in industries in both private and public sectors such as manufacturing and processing industries, industries related to petroleum, chemical, ceramic, polymer, food, electronics, the environmental, mining, pharmaceuticals and health-related industries, agriculture industries, government agencies, including forensic science and patents, defence, education and research, and areas related to biotechnology. The degree also allows them to pursue postgraduate studies in chemistry and related areas.

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 Industrial 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	ICPT-101	Industrial 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	Industrial 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	ICPT-303	Industrial 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	ICPT-404	Industrial 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	ICPT-505	Industrial 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	ICPT-606	Industrial 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



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SEMESTER I

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 hydrogenic 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_l 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-Landé 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.

7 :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 Huckel's 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, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis* alkenes

and trans alkenes (Birch reduction). *Reactions:* 1 trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-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 Alexander: *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 $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.

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 Greensø theorem in Plane.

Mechanics (Total Number of lectures =30)

Dynamics of a system of particles, Centre of mass, Conservation of momentum. Newtonø 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, Keplerø Laws (Only Statement).

Elasticity: Hookø 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. Schaumø 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 Helmholtz 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.



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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.

ICPT-101: INDUSTRIAL CHEMISTRY-1: INDUSTRIAL CHEMICALS AND ENVIRONMENT

I. Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

2. Industrial Gases and Inorganic Chemicals

(a) Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

(b) Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

III Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultra pure metals for semiconductor technology.

3. Environment

(a) Air Pollution: Pollutants and their sources, pollution by SO_2 , CO_2 , CO , NO_x , H_2S and other foul smelling gases. Methods of estimation of CO , NO_x , SO_x and control procedures. Green House effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

(b) Water pollution and Water Quality Standards: Pollutants and their sources, Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluent from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

INDUSTRIAL CHEMISTRY

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method. (AgNO_3 and potassium chromate)
6. Estimation of total alkalinity of water samples (CO_3 , HCO_3) using double titration method.
7. Measurement of dissolved CO_2 .
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Suggested Readings

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: *Riegelø's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. A. K. De, *Environmental Chemistry*: New Age International Pvt, Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

PAPER-4

ENPT- 101: TECHNICAL WRITING AND COMMUNICATION IN ENGLISH

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 Regents.
2. L. Hamp-Lyons and B. Heasley: 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*” - Biztantra.

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).

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.openoffice.org>



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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.



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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 (U) and enthalpy (H) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w , q , U and H 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 Kirchhoff's 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. Maxwell's 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 G and G° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

polytes, 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-Crafts 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 (SN₁, SN₂ and SN_i) reactions. *Preparation*: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & iso-nitrile formation. Williamson 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: KNH₂/NH₃ (or NaNH₂/NH₃).

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. KMnO₄, acidic dichromate, conc. HNO₃). Oppeneauer oxidation

Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

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

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

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

Preparation: from acid chlorides and from nitriles.

Reactions ó Reaction with HCN, ROH, NaHSO₃, NH₂-G derivatives. Iodoform
test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin
condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-
Ponndorf 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 Learning 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)

R^1 , R^2 , R^3 as vector spaces over R . Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R^2 , R^3 , 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 linear 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 $(-1)^n/n$, $1/n^2$, $(1+1/n)^n$, $\sin n/n$, x^n 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 Taylor's Maclaurin's 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.



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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 Apostol: 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.

ICPT-202: INDUSTRIAL CHEMISTRY-2: FOSSIL FUELS, CLEANSING AGENTS AND FOOD ADDITIVES

1. Fuel Chemistry

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

- (a) **Coal:** Uses of coal (fuel and non fuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro Gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.
- (b) **Petroleum and Petrochemical Industry:** Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.
- (c) **Lubricants:** Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pour point) and their determination.

2. Oils and Fats

Classification of oils, fat splitting, distillation of completely miscible and non-miscible oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value, Soap and Synthetic Detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS, LABS), detergent binders and builders.

3. Food additives

A general study of food flavours, colours and preservatives, artificial sweeteners.

ICPP-202: PRACTICAL INDUSTRIAL CHEMISTRY

1. Determination of alkali in water samples and soaps.
2. Separation of essential oils by soxhlet extractor.
3. Analysis of oils and fats (iodine value, saponification value, acid value).
4. Testing of turmeric powder, milk and mustard oil for adulterants.
5. Estimation of glucose in food samples.
6. Extraction of natural coloring and flavoring agent from flowers and fruits
7. Estimation of hardness of water by titration with soap solution.
8. Estimation of Available Oxygen in Hydrogen Peroxide.
9. Preparation of soap.

Suggested Readings

1. O. P. Vermani, A. K. Narula: *Industrial Chemistry*, Galgotia Publications Pvt. Ltd., New Delhi.
2. S. C. Bhatia: *Chemical Process Industries*, Vol. I & II, CBS Publishers, New Delhi.
3. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
4. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
5. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut.

PAPER-8

ENPT-101: TECHNICAL WRITING AND COMMUNICATION IN ENGLISH

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 Regents.
2. L. Hamp-Lyons and B. Heasley: 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*” - Biztantra.

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).

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



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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 of 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-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, $\text{FeCl}_3\text{-H}_2\text{O}$ 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,

properties: G, H and S from EMF data.
at 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, Gabriel's Phthalimide synthesis, Hofmann
Bromamide reaction.

Reactions: Hofmann Vs Saytzeff elimination, Carbylamine test, Hinsberg test,
with HNO₂, 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, disaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (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 Solomonø: *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

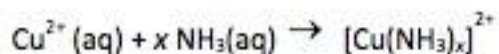
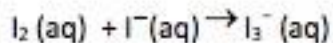
Section A: Physical Chemistry

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 hydroxideMeasurement of the pH of buffer solutions and comparison of the

l values.

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



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 Z_n 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 $GL_n(n, R)$, 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

ICPT-303: INDUSTRIAL CHEMISTRY-3: INORGANIC MATERIALS

1. Silicate Industries

- (a) **Glass:** Glassy state and its properties, classification (silicate and non silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.
- (b) **Ceramics:** Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, super conducting and semi conducting oxides, fullerenes carbon nanotubes and carbon fiber.
- (c) **Cements :** Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

2. Fertilizers:

Fertilizers: Different types of fertilizers. Manufacture of the following fertilizers: Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphates; Polyphosphate, Super phosphate, Compound and mixed fertilizers Potassium Chloride, Potassium sulphate.

3. Surface Coatings

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

4. Battery

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel Cells, Solar cell and polymer cell.

5. Alloys

Classification of alloys, Ferrous and Non-Ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization,

ation dephosphorisation) and surface treatment
ment, nitriding, carburizing). Composition and

properties of different types of steels.

6. Catalysis

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts.

7. Chemical Explosive

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction of rocket propellant.

INDUSTRIAL CHEMISTRY

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Suggested Readings

1. E. Stocchi: *Industrial Chemistry*, Vol-I, , Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: *Riegelø's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

PAPER-12

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: α -helix and β -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 Green Chemistry 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 its 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.

living organisms and vegetation, Controls of air Green house effect, global warming. Techniques

of measuring air pollutants.

- Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods.

Unit IV:

- Energy and Environment: Sources of energy: Coal, petrol and Natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel etc.
- Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its 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, Harper's 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 Lowry's method. Determine the concentration of the unknown sample using the standard curve plotted.

Salivary amylase at optimum conditions.

Effect of salivary amylase.

4. Effect of temperature on the action of salivary amylase.
5. Effect of inhibitor on the action of salivary amylase.
6. Study of the activity of Trypsin using fresh tissue extracts.
7. To study the effect of temperature, 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.



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SEMESTER IV

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 Mondø 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 equation. 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, Braggó 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).

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 H₂S of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH₄⁺, Pb²⁺, Ag⁺, Bi³⁺, Cu²⁺, Cd²⁺, Sn²⁺, Fe³⁺, Al³⁺, Co²⁺, Cr³⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, K⁺

Anions : CO₃²⁻, S²⁻, SO₃²⁻, S₂O₃²⁻, NO₃⁻, CH₃COO⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₄²⁻, PO₄³⁻, BO₃³⁻, C₂O₄²⁻, 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.

- critical 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.

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 of 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, quality 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: Young's 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, Rayleigh's



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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.

L 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 (α) by Platinum Resistance Thermometer (PRT). Assume $R_{100} = \dots$.
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 using 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

ICPT-404: INDUSTRIAL CHEMISTRY-4: PHARMACEUTICALS, FERMENTATION, PESTICIDES & PERFUMES

1. Drugs and Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

2. Cosmetics and Perfumes

A general study including preparation and uses of the following: Hair dye, hair spray, Shampoo, Sun-tan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, -phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

3. Pesticides

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil) , Anilides (Alachlor and Butachlor).

4. Fermentation Industries

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Pencillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamine B2 Vitamine B12 and Vitamine C.

INDUSTRIAL CHEMISTRY

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of Aspirin and its analysis.
7. Preparation of nail polish and nail polish remover.
8. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
9. Preparation of simple organophosphates, phosphonates and thiophosphates
10. Preparation of Magnesium bisilicate (Antacid).

Suggested Readings

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.
4. G.L. Patrick: *Introduction to Medicinal Chemistry*, Oxford University Press, UK.
5. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
6. R. Cremllyn: *Pesticides*, John Wiley.
7. William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt Ltd. New Delhi.

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.

Integrated circuits

Circuit Boards, Integrated 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) World 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.



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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.

equation 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-Beer's 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.

AL 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 λ_{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 Jobø'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) Mohrø'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 curl 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, and 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., at 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. Workshop 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

ICPT-505: INDUSTRIAL CHEMISTRY-5: DYES AND POLYMERS

1. Dyes:

General introduction and classification with special reference to textile and edible dyes and fabric brighteners. Industrial preparation and uses of methyl orange, malachite green, indigo, bismark brown, alizarin.

2. Polymers

1. *Organic Polymers*: Preparation, Properties, Classification, Structure property relationship (Thermoplastic and Thermosetting). Industrial manufacture of the monomers and the following polymers, Polystyrene, Polyacrylonitrile, Polymethacrylate, Polymethylmethacrylate, Polyethene, Polybutadiene, Polyvinylidene, Polycarbonates, Polyesters, Polyurethanes, Nylon (6,6:6,6:10), Phenolic polyesters, Polyamides, Polysulphones, Alkyds. Speciality Polymers (Electro-luminescent, Biopolymers, Conducting polymers), Rubbers (synthetic and natural) and their processing, Elastomers, Cellulosics, Natural and Synthetic fibers, fiber processing, anti wrinkle and flame retardant. Comparison of natural and synthetic polymers, relation between molecular structure and properties. Polymer Processing: Moulding, compounding, blending. Polymer designing: packaging, certification and process evaluation.
2. *Inorganic Polymers*: Classification, preparation, properties and uses of boron containing polymers, phosphorus containing polymers, silicon containing polymers, Silicones (fluid, elastomers and resins) and sulphur containing polymers(SN)_x.

ICPP-505: PRACTICAL INDUSTRIAL CHEMISTRY

1. Preparation of Malachite Green.
2. Preparation of Methyl Orange.
3. Preparation of Maleic Anhydride/ glyptal resin.
4. Preparation of Caprolactum.



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6. Preparation of phenol formaldehyde and urea formaldehyde.
7. Preparation of Hexamethylenediamine and Adipic acid.
8. Preparation of nylon 6,6.
9. Molecular weight determination of a polymer (nylon 6,6) by end group analysis.
10. Estimation of amino acid.
11. Estimation of amino group.

Suggested Readings

1. K.J. Saunders: *Organic Polymer Chemistry*, Chapman & Hall, London.
2. P.J. Flory: *Principles of Polymer Chemistry*, Cornell University Press, NY.
3. G. Odian: *Principles of Polymerization*, John Wiley & Sons Inc, NY.
4. James E. Mark, Harry Allcock, Robert West, *Inorganic Polymers*, Prentice Hall Englewood.

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 I 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

ization ó careful use of blocking/protecting
stochastic reagents (wherever possible) in preference to
stoichiometric reagents; 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 öClayanö, a non-metallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in Organic Syntheses; Biocatalysis in Organic Syntheses.

Green Chemistry

Oxidation reagents 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. Warner: 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. Tinneland, 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

merizations, Mechanism and kinetics of polymerization techniques.

- Unit IV** Crystallization and 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 (M_n , M_w , 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 (T_g) and determination of T_g , Free volume theory, WLF equation, Factors affecting glass transition temperature (T_g).
- 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 Polypyrrole, Polythiophene)].

Suggested Readings

1. *Seymour Polymer Chemistry*, Marcel Dekker, Inc.
2. G. Odian: *Principles of Polymerization*, John Wiley.
3. F.W. Billmeyer: *Text Book of Polymer Science*, John Wiley.

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.

gy

Cell culture and production of bio-products, gene manipulation and transgenic technology, 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.

- Introduction, Conventional methods of chemical analysis; Preliminary tests (colour & spot); Drugs of Abuse: Introduction and classification; Forensic Toxicology: Introduction and General methods of 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



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and Sex determination from skull, estimation of
es, hair morphology, tests for fiber identification.

Suggested Readings

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).



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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 -acceptor behaviour 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.

of COOH group, acetylation of NH_2 group,
Hydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.
Determination of Primary structure of Peptides by degradation Edmann
degradation (N-terminal) and C-terminal (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 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 $\text{C}=\text{O}$ 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.

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/ Mathematica/ Maple/ MuPadeharacteristics, 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).

ICPT-606: INDUSTRIAL CHEMISTRY-6: INSTRUMENTAL METHODS OF ANALYSIS

1. Quality Control and Instrumental Methods of Analysis

- A. *Purification and Separation*: Sample preparation (isolation using a suitable solvent, extraction and separation), Solvent extraction. Distillation (simple, fractional and vacuum distillation), Crystallization. Chromatographic separation: High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gas Chromatography (GC), Ion Exchange Chromatography.
- B. *Composition Analysis*: Elemental analysis both qualitative and quantitative.
- C. *Physical Characterization*: Strength, Viscosity, Rheological properties, Molecular weight.
- D. *Spectroscopic Methods*: Ultraviolet Spectrophotometry (UV), Visible Spectro photometry, Infrared Spectrophotometry (IR), Nuclear Magnetic Resonance Spectroscopy (NMR) and Electron Spin Resonance Spectroscopy (ESR), Flame Photometry, Atomic Absorption Spectroscopy (AAS), Induced Couple Plasma Spectroscopy (ICP), Atomic Fluorescence Spectroscopy.
- E. *Electro Analytical Techniques*: Potentiometry, Voltametry, Polarography, Amperometry, Coulometry and Conductometry.
- F. *Thermal Methods of Analysis*: Thermal Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Thermal Mechanical Analysis (TMA).
- G. *STANDARDS*: ISI, BTS, ISO, EURO, ASTM.

ICPP-606: PRACTICAL INDUSTRIAL CHEMISTRY

1. Determination of composition of dolomite (by complexometric titration).
2. Thermal Characterization of the following: (Demonstration exercise)
 - (i) Dolomite (for percentage composition by TGA)
 - (ii) Polystyrene (for glass transition temperature by DTA)



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ercises on the use of IR, Mass, UV and NMR
rcise).

4. An industrial project*

Suggested Readings

1. H.H. Willard, L.L. Merrit, J.A. Dean, F. A. Settle: *Instrumental Methods of Chemical Analysis*, Wadsworth Publishing Company, California.
2. G. D. Christian: *Analytical Chemistry*, John Wiley, NY.
3. S.M. Khopkar: *Basic Concepts of Analytical Chemistry*, Wiley Eastern Ltd, New Delhi.

***Industrial Project:** Every student should undergo training Programme for the preparation and characterization (chemical as well as physical) of an industrial useful chemical/ any other investigatory project, in order to promote innovativeness, under the guidance and supervision of concerned faculty of college.



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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.