

DEPARTMENT OF APPLIED CHEMISTRY
BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI

Name of the course:	Integrated M. Sc. (Chemistry)
Duration:	10 semesters
Intake:	20
Eligibility:	10+2 with Physics, Chemistry, Maths/Biology with 60% mark as average of marks in four subjects (ECPM/B) (50% for SC/ST category)
Exit Option:	Candidates may be allowed to exit from the programme after successfully completing their VI Semester. However the candidate has to submit in writing their intention to exercise this option at the time of registration of IV Semester. Such candidates would be given B.Sc. Degree with Chemistry (Hons./Major).

COURSE AIMS & OBJECTIVE

The proposed course aims to provide students with a broad theoretical background in Inorganic, Organic & Physical Chemistry, with emphasis on Analytical Techniques. Particular attention is given to Industrial applications of chemistry so that students are completely equipped to move into careers in academic, industrial and commercial organizations. The course curriculum is interdisciplinary in nature involving applied chemistry, applied physics, mathematics and biological sciences. Our institute has a good number of experts in these areas along with basic instrumentation facilities. The content of the course provides an understanding of different aspect of chemistry. The lecture based course will cover the various aspects of pure & applied chemistry. In lab experiments the emphasis is laid on green chemistry and industrial chemistry elaborating the need for waste minimization, substitution of non toxic chemicals for toxic ones and increasing the use of semi-micro, micro and computational techniques. Laboratory courses have been designed to provide an exhaustive and hands on experience on working with various sophisticated instruments. Final semester is dedicated to thesis/dissertation work giving students experience in solving a real-life problem under the supervision of faculty members involved in pursuing research and development projects, usually related to industrial problems.

Employment Potential:

To provide properly qualified man power for academic institutions, R&D and quality control laboratories of chemical / pharmaceutical industries & forensic labs. This will also fulfill the needs of the students regarding the limited exposure to modern instrumental techniques in various graduate and postgraduate courses, thus enabling them for employment in chemical, pharmaceutical industries, R & D laboratories, academic institution, forensic labs etc. More over this course can be helpful to the students to be self employed as it not only allows for an in-depth subject specific knowledge and opportunities to specialize in a number of areas at the leading-edge of the subject but also encourages students to develop problem solving and reflective working practices.

COURSE STRUCTURE

1st Semester	Subject Code	Subject	L-T-P	Credits	(C)/ (B)
	ISP 1001	Physics I (General Properties of Matter and Waves & Oscillations)	3-1-0	4	C
	ISC 1001	Chemistry I	3-0-0	3	C
		Mathematics I (Analytical Geometry and Calculus)	3-1-0	4	C
	CS	Unix & C-Programming	3-0-2	4	B
		English	2-1-0	3	B
	ISP1002	Physics Lab I	0-0-2	1	C
		Chemistry Lab I	0-0-2	1	C
		Co Curricular Activity	0-0-2	1	B
		Total Credits		21	C-13 B-7
2 nd Semester	ISP 2001	Physics II (Basic Electromagnetic Theory)	3-0-0	3	C
	ISC 2002	Chemistry II	3-1-0	4	C
		Mathematics II (Matrix Algebra & Complex Variables)	3-0-0	3	C
		Data Structure	3-0-2	4	B
		Environmental Science	3-0-0	3	B
	ISP 1004	Physics Lab II	0-0-2	1.5	C
		Chemistry Lab II	0-0-2	1.5	C
		Co Curricular Activity	0-0-2	1	B
		Total Credits		21	C-13 B-8
3 rd Semester	ISP 3001	Physics III (Modern Physics)	3-0-0	3	C
	ISC 2003	Chemistry III	3-0-0	3	C
		Maths III (Ordinary Differential Equations with Special Functions)	3-1-0	4	C
	CS	Java Programming & Web Technology	3-0-2	4	B
		Biological Science	3-0-0	3	B
		Physics Lab-III	0-0-2	1.5	C
		Chemistry - Lab III	0-0-2	1.5	C
		Co Curricular Activity	0-0-2	1	B
		Total Credits		21	C-13 B-8
4 th Semester		Physics IV (Modern Optics)	3-0-0	3	C
	ISC 2004	Chemistry IV	3-0-0	3	C
		Maths IV (Integral Transform & Partial Differential Equations)	3-1-0	4	C
		Value Education, Human Rights and Legislative Procedure	3-0-0	3	B
	ISP 4003	Solid State Physics	3-1-0	4	C
	ISP 4002	Physics Lab-IV	0-0-3	1.5	C
		Chemistry Lab IV	0-0-3	1.5	C
		Co Curricular Activities	0-0-2	1	B
		Total Credits		21	C-17 B-4

	Code	Subject	L-T-P	Credits	(C)/(B)
5 th Semester		Physical Chemistry I	3-1-0	4	C
		Organic Chemistry I	3-1-0	4	C
		Organic Chemistry II	3-0-0	3	C
		Inorganic Chemistry I	3-0-0	3	C
		Inorganic Chemistry II	3-0-0	3	C
		Inorganic Chemistry Lab -I	0-0-3	1.5	C
		Organic Chemistry Lab -I	0-0-3	1.5	C
		Total Credits		20	C-20
6 th Semester		Physical Chemistry II	3-0-0	3	C
		Physical Chemistry III	3-0-0	3	C
		Organic Chemistry III	3-0-0	3	C
		Inorganic Chemistry III	3-0-0	3	C
		Foreign Language	2-0-1	2	B
		Industrial Chemistry	3-0-0	3	C
		Physical Chemistry Lab -I	0-0-3	1.5	C
		Industrial Chemistry Lab	0-0-3	1.5	C
		Total Credits		20	C 18 B 2
7 th Semester		Advanced Physical Chemistry	3-1-0	4	C
		Organic Reaction Mechanisms	3-1-0	4	C
		Metal Chemistry	3-0-0	3	C
		Environmental Chemistry	3-0-0	3	C
		IPR	3-0-0	3	B
		Computational Chemistry Lab	0-0-3	1.5	C
		Organic Chemistry lab II	0-0-3	1.5	C
		Total Credits		20	C 17 B 3
8 th Semester		Theoretical Chemistry	3-0-0	3	C
		Synthetic Organic Chemistry	3-1-0	4	C
		Advanced Analytical Techniques	3-0-0	3	C
		Advanced Inorganic Chemistry	3-1-0	4	C
		Environmental Monitoring and Control	3-0-0	3	C
		Inorganic Chemistry Lab II	0-0-3	1.5	C
		Physical chemistry Lab II	0-0-3	1.5	C
		Total Credits		20	C-20
9 th Semester		Bio-Inorganic & Organometallic Chemistry	3-1-0	4	C
		Advanced Organic Chemistry	3-1-0	4	C
		Elective I	3-0-0	3	C
		Elective II	3-0-0	3	C
		Breadth Paper: PG Lever (Oth Dept.)	3-0-0	3	B
		Advanced Characterization Lab	0-0-3	1.5	C
		Elective Lab	0-0-3	1.5	C
		Total Credits		20	C 17 B 3
10 th Semester		Thesis /Dissertation		10	
		TOTAL CREDIT		194	

Syllabus of Chemistry I-X

ISP 1001 Physics I - General Properties of Matter and Waves & Oscillations (3-1-0-4)

Module 1 [6]

Systems of particles: Centre of mass, Linear momentum, Conservation of linear momentum, System with varying mass: A Rocket; Potential energy and conservation of energy, Conservative and non-conservative forces, Force as gradient of potential energy; Particle collisions: Elastic and inelastic collision.

Module II [6]

Angular momentum of a particle and system of particles, Angular momentum of rigid body rotating about a fixed axis, Conservation of angular momentum, Torque, Rotation about a fixed axis. Moment of inertia and its calculation

Module III [5]

The world and gravitational force, Newton's law of gravitation, Gravitation near earth's surface, Gravitation inside earth, Gravitational potential energy, Planets and satellites: Kepler's Laws.

Module IV [5]

Torsion of a cylinder, Bending moment, Cantilever, Beam supported at both ends, Beams clamped at both ends, Reciprocity theorem; Elastic energy in different types of deformation.

Module V [6]

Molecular forces, Surface tension and surface energy, Angle of contact, Excess pressure over a curved liquid surface, Capillarity, Shape of liquid drops. Ripples, Streamline and turbulent motion, Reynold's number; Poiseuille's equation. Stoke's law, Rotating cylinder and rotating disc methods for determining the coefficient of viscosity, Euler's equation for liquid flow; Bernoulli's theorem and its applications.

Module VI [8]

Simple harmonic motion, Motion of simple and compound pendulum, Damping, Forced vibration and resonance, Wave equation in one dimension, Phase velocity, Group velocity, Dispersion. Types of wave, Transverse and longitudinal waves. Speed of a travelling waves, Wave speed on a stretched string, Energy and power of a travelling string wave, The principle of superposition for waves, Interference of waves, Stationary waves, Sound waves, speed of sound Intensity of sound. Measurement of intensity; The Doppler effect, Shock waves

Text Books:

1. Fundamental of Physics, Halliday D., Resnick R. and Walker J., Wiley India
2. Sears and Zemansky's University Physics, Young H.D., Freedman R.A., Ford A.L., Pearson
3. General properties of Matter, Newman and Searle
4. Properties of Matter: C. J. Smith

Reference Books:

1. Mechanics, D.S.Mathur.
2. Mechanics, Shukla R.K. and Srivastava A.
3. Physics Course vol. I, Berkley
4. Textbook of sound, Wood A. B.
5. Waves and Oscillations, French

Chemistry-I

Credit: 3 (3-0-0)

Module I: Atomic Structure & Periodic Properties

[5]

Atomic Structure, Electronic Configuration, Atomic and ionic radii, ionization energy, electron affinity and electronegativity, trends in periodic table and applications in predicting and explaining the chemical behaviour.

Module II: Chemical Bonding

[7]

Covalent Bond – Valence bond theory and its limitations, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , ICl_2 and H_2O . MO theory, homonuclear diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference. Weak Interactions – Hydrogen bonding, Van der Waals forces.

Module III Gaseous & Liquid States of Matter

[8]

Postulates of kinetic theory of gases, deviation from ideal behavior, van der waals equation of state. Law of corresponding states. Molecular velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule Thomson- effect) Intermolecular forces, structure of liquid. Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell.

Module IV Introductory Organic Chemistry

[7]

IUPAC nomenclature: Alkanes, cyclo-alkanes, alkenes, alkynes, halogen compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds. Hybridization and Geometry of Molecules: methane, ethane, ethylene, acetylene. Electronic Effects: Inductive, resonance, hyper conjugation and steric effect. Cleavage of bonds: homolytic and heterolytic C-C bond fission. Reaction Intermediates and their stability: carbocations, carbanions and free radicals.

Module V: Basic Organic Synthesis and Principles

[8]

Alkanes: preparation by reduction of alkyl halides, Wurtz reaction and Kolbe's electrolytic methods with mechanism; Alkenes: preparation by dehydration of alcohols, dehydrohalogenation of alkylhalides, dehalogenation of vicdihalides and by Kolbe's electrolytic method. Alkynes: Preparation by dehydrohalogenation of vic-dihalides and gem-dihalides, dehalogenation of tetrahalides and Kolbe's electrolytic method. Reactions: addition reactions with hydrogen, halogens, hydrogen halide (markownikoffs rule, peroxide effect), hydroboration, ozonolysis, hydroxylation with KMnO_4 , allylic substitution by NBS. Conjugated Dienes; Electrophilic addition of dienes: 1,2, & 1,4 addition, Diels . Alder reaction

Books Recommended:

1. Organic Chemistry, Morrison and Boyd, Prentice Hall.
2. Advanced Organic Chemistry, Bahl, B S, Bahl A.
3. Physical Chemistry by P. W. Atkins, Elbs
4. Basic Inorganic Chemistry by F. A. Cotton & Wilkinson, John Wiley
5. Inorganic Chemistry by J. E. Huhey, Harpes & Row

IMC 1001 Mathematics I - Analytical Geometry and Calculus (3-1-0- 4)

Module I

Analytical Geometry (2D & 3D): Polar equation of conics. Cones, cylinders and conicoids, Central conicoids, normals and conjugate diameters. [6]

Module II & III

Differential Calculus: Successive differentiation of one variable and Leibnitz theorem, Taylor's and Maclaurin's expansion of functions of single variable. Functions of several variables, partial derivatives, Euler's theorem, derivatives of composite and implicit functions, total derivatives, Jacobian's. Taylor's and Maclaurin's expansion of functions of several variables, Maxima and minima of functions of several variables, Lagrange's method of undetermined multipliers, Curvature and asymptotes, concavity, convexity and point of inflection, Curve tracing. [12]

Module IV

Integral Calculus: Improper integrals, convergence of improper integrals, test of convergence, Beta and Gamma functions and its properties, Differentiation under integral sign, differentiation of integrals with constant and variable limits, Leibnitz rule. [6]

Module V

Evaluation of double integrals, Change of order of integrations, change of coordinates, evaluation of area using double integrals, Evaluation of triple integrals, change of coordinates, evaluation of volumes of solids and curved surfaces using double and triple integrals. Mass, center of gravity, moment of inertia and product of inertia of two and three-dimensional bodies and principal axes. [6]

Module VI

Vector Calculus: Scalar and vector fields, Level surfaces, differentiation of vectors, Directional derivatives, gradient, divergence and curl and their physical meaning, vector operators and expansion formulae, Line, surface and volume integrations, Theorems of Green, Stokes and Gauss, Application of vector calculus in engineering problems, orthogonal curvilinear coordinates, expressions of gradient, divergence and curl in curvilinear coordinates. [6]

Books:

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Education, 2008
2. Dennis G. Zill, Warren S. Wright: Advanced Engineering Mathematics, 4th edition, Jones and Bartlett Publishers, 2010
3. E. Kreyszig : Advanced Engineering Mathematics, 8th Edition John Wiley and sons 1999.
4. T. M. Apostol : Calculus Vols I and II, 2nd Edition, John Wiley and sons, 1967 and 1969.
5. Murray R Spiegel, Theory and problems of Vector Analysis and an Introduction to Tensor Analysis, McGraw Hill, Schaum's Outline Series

CS UNIX and C Programming (3-0-2-4)

MODULE – I

Fundamentals of Unix Operating System, Login & Password, Different Commands, Unix directory, Structure and working with directories, Vi-editor, History and Importance of C, Sample programming, Basic Structure and execution of C programmes, Constants, Variables, and Data Types and various type of declarations, Different type operators and Expressions, Evaluation of Expressions, Operator Precedence and Associability, Mathematical Functions.

MODULE –II

Managing Input and Output operations, Decision Making and Branching Decision Making and Looping.

MODULE – III

One – dimensional Arrays and their declaration and Initialisations, Two-dimensional Arrays and their initialisations, Multidimensional Arrays, Dynamic Arrays, String Variables, Reading and Writing Strings, Arithmetic Operations on characters, Putting Strings together, Comparison of Two Strings, String – handling functions, Table and other features of Strings.

MODULE –IV

Need and Elements for user –defined Functions, Definition of Functions, Return values and their types, Function calls and Declaration, Arguments and corresponding return values, Functions that return multiple values, Nesting of functions, Recursion, Passing arrays and strings to functions, The Scope, Visibility and Life time of variables.

MODULE –V

Defining Structure, Declaring Structure Variable and Accessing Structure Members, Initialisation of Structure, Comparing Structure Variables, Operation on Individual Members, Arrays of Structures, Structures within structures, Structures and Functions, Unions, Size of Structures, Bit Fields.

MODULE – VI & VII

Understanding Pointers, Accessing the Address of a Variable, Declaration and Initialisation of Pointer Variables, Accessing a Variable through its Pointer, Chain of Pointers, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and Arrays, Pointers and Arrays, Pointers and Character Strings, Arrays of Pointers, Pointers and Function Arguments, Functions Returning Pointers, Pointers to Functions, Pointers and Structures, File Management in C.

Text Book :

E. Balagurusamy – Programming in ANSI C, 3rd Edn. , TMH, New Delhi ; 2004

Reference:

A. N. Kanthane – Programming with ANSI and TURBO C, Pearson Education, New Delhi; 2004
Y. Kanetkar – Let us C, 4th Edition, BPB Publication , New Delhi; 2002.

ENGLISH (2-1-0-3)

MODULE 1:

1. Short stories
 - A) The castaway – Rabindra nath Tagore
 - B) Mr. know all - somerset Maugham
2. Essays
 - a) Life's Philosophy – Jawaharlal Nehru
 - b) Ideas that have helped mankind – Bertrand Russell
3. Vocabulary
 - a) One word substitution
 - b) Idioms & Phrases
 - c) Pairs of word
 - d) Synonyms & Antonyms
4. Comprehension

MODULE 2:

1. Communication
 - a) Definition & Meaning
 - b) Effective communication
 - c) Barriers to communication
 - d) Verbal & Non- Verbal communication
2. Official correspondence
 - a) Memorandum
 - b) Notice, Agenda, Minutes
 - c) Invitation letter for Seminar etc.
 - d) Refusal & Acceptance letter
3. Drafting C.V. & writing Application
4. Paragraph writing

Reference books:

1. Selected short stories , Prof. Damodar Thakur(ed)- Mcmillan India Ltd.
2. Modern Masters – An Anthology of English prose; Bord of editors- Orient longman
3. Student's Companion- W D Best - Rupa & Co.
4. Effective Business Communication- Asha Kaul- Prentice Hall of India
5. Business Communication- Satya Swaroop Debasish, Bhagban Das- Prentice hall of India

ISP 1002 Physics Lab-1 (0-0-2-1)

1. Error analysis using vernier calipers, screw gauge, and spherometer
2. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of material of a wire using Searle's method.
3. Determination of Young's modulus of material of a metallic bar by bending of beam method.
4. To study the standing waves on a stretched string and verify the relation between tension, frequency and number of loops.
5. To determine the frequency of ac mains supply using sonometer.
6. Determination of viscosity of liquid using Poiseuille's method.
7. Determination of surface tension of a liquid by capillary tube method.
8. Determination of acceleration due to gravity using compound pendulum

Chemistry Lab-1 (0-0-2-1)

1. Demonstration & concept of good lab practices including safety, glassware handling, chemical nature understanding, chemical handling, chemical/glassware waste management, Error Analysis, notebook maintenance.
2. Calibration and handling of balances, pipettes and burettes, basic principles & experiments related to sample & reagent preparation: practical concept of Molarity, Molality, Normality, equivalence, weight %, vol.%, Preparation of standard solutions, Dilution 0.1 M to 0.001 M solutions.
3. Calibration of Thermometer
 - a. 80-82 C (Naphthalene), 113.5-114 C (Acetanilide)
 - b. 132.5-133 (Urea), 100 C (Distilled Water)
4. Determination of Melting Point
Naphthalene 80-82 C, Benzoic Acid 121.5-122 C
Urea 132.5-133 C, Succinic Acid 184.5-185
Cinnamic Acid 132.5-133, Salicylic Acid 157.5-158 C
Acetanilide 113.5-114 C, m-Dinitrobenzene 90 C
p-Dichlorobenzene 52 C, Aspirin 135 C
5. Determination of Boiling Point
 - a. Ethanol 78 C, Cyclohexane 81.4 C, Toluene 110.6 C
6. Crystallization
 - a. Phthalic acid from hot water (using fluted filter paper and stemless funnel)
 - b. Acetanilide from boiling water
 - c. Naphthalene from ethanol
 - d. Benzoic acid from water
7. Distillation
 - a. Simple distillation of ethanol-water mixture using water condenser
 - b. Distillation of nitrobenzene and aniline using air condenser
8. Macro analysis (qualitative) of cations and anions (known samples)

Books Suggested:

1. Vogel's Textbook of Practical Organic Chemistry
2. Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
3. Vogel's Textbook of Practical Organic Chemistry (5th Edition)
4. Vogel's Inorganic Practical Chemistry

Co-curricular Activity (0-0-2-1)

ISP 2001 Physics II - Basic Electromagnetic Theory (3-0-0-3)

Fields: [6]

Vector and scalar fields, physical and mathematical concepts of gradient, divergence and curl, Gauss's theorem and Stokes' theorem.

Electrostatics: [9]

Coulomb's law, Gauss's law in integral and differential form, electric potential and relation with E , electrostatic energy density, dielectrics, Relation between E , D and P vectors, dielectric susceptibility, boundary conditions on E and D .

Magnetism: [9]

Motion of charged particles in electric and magnetic fields, Biot-Savart law, Ampere's law in integral and differential form, applications, Hall effect.

Types of magnetism – diamagnetism, paramagnetism and ferromagnetism, Weiss field, domains, magnetic permeability and susceptibility, Relation between B , H and M vectors, boundary conditions on B and H , hysteresis.

Electromagnetic theory: [12]

Faraday's law of electromagnetic induction in integral and differential form, Inductance, magnetic energy density, continuity equation for charge, displacement current, Maxwell's equations in free space, electromagnetic wave equation for plane waves in dielectric medium and free space, relation between E , B , and k , Poynting vector, radiation pressure.

Text books:

1. Fundamental of Physics: Halliday, Resnick & Walker (6th Edition)
2. Engineering Electromagnetics: William Hayt, John Buck, McGraw-Hill Companies (7th Edition)

Reference books:

1. Introduction to Electrodynamics: David J Griffiths, 3rd Ed.
2. Electricity and Magnetism: Jackson

Chemistry II (3-1-0-4)

Module- I Colloidal State [5]

Definition of colloid, classification of colloids. Solids in liquids (sols): properties – kinetic, optical and electrical: stability of colloids, protective action Hardy-Schulze law, gold number. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.

Module-II Chemical kinetics and Catalysis [6]

Introduction to chemical kinetics Theories of chemical kinetics: effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy, Simple collision theory based on hard sphere model transition state theory (equilibrium hypothesis) Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Catalysis, characteristics of catalysed reactions, classification of catalysis, miscellaneous examples.

Module III: s- and p- Block Elements [5]

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies, an introduction to alkyls and aryls.

Chemical properties of the noble gases, chemistry of xenon, structure and bonding xenon compounds Role of Mg, Na, K, Ca ions in biology.

Module IV: Acids and Bases [4]

Arrhenius, Bronsted-Lowry, solvent system, Lewis and HSAB concept of acids and bases.

Module V Aromatic Compounds & Aromaticity [5]

Aromatic hydro carbons and aromaticity, resonance in benzene, Huckel's $(4n+2)$ rule and its simple applications. Acidic character of phenols - explanation on the basis of resonance stabilization. Electrophilic substitution reactions in aromatic compounds. General mechanisms of nitration, halogenation, sulphonation, Friedel-Craft's acylation and alkylation, ortho/para/meta directive influence with examples.

Module VI Elimination & Substitutions Reactions [5]

SN1 and, SN2 reaction mechanism: effects of structure, substrate, solvent, nucleophile and leaving groups. Mechanisms of E1 and E2 reactions, Hoffmann and Sayetzeffs rules cis and trans eliminations, Elimination Vs substitution.

Module VII Stereochemistry [6]

Introduction, Concept of Isomerism, Classification of Stereoisomers, Optical isomerism, Chirality & Elements of symmetry, Wedge formula, Fischer projection, Newmann projection. Relative and absolute configurations, sequence rules, D & L, R & S systems of nomenclature. Understanding with examples for Enantiomers, mesoform, erythro/threo forms, diastereoisomers, inversion, retention, and racemization. Conformational understanding with an example of ethane, n-butane, Cyclohexane and Decalin.

Books Recommended:

1. Fundamentals of Organic Chemistry Solomons, John Wiley
2. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
3. Physical Chemistry Vol. 1-5, by K.L Kapoor
4. Physical Chemistry: A Molecular Approach by McQuarrie & Simon Viva
5. Concise Inorganic Chemistry by J D Lee, Amazon.
6. Comprehensive Co-ordination Chemistry by G. Wilkinson, R. D. Gillars & J. A. McCleverty, Pergamon
7. Chemistry of the Elements by N. N. Greenwood & Earnshaw, Pergamon

IMC 2001 Maths II - Matrix Algebra & Complex Variables (3-0-0-3)

Module I

Inequalities- A.M., G.M. Cauchy Schwartz inequality, Weirstrass's inequality, Holder's inequality. Simple Continued Fractions [3]

Module II

Infinite serie -- Convergency and divergency of Infinite series. Comparison test, D' Alembert's Ratio test, Raabe's test, logarithmic test, Cauchy's root test, Higher Logarithmic ratio Test, Gauss's Test, Alternating series, Leibnitz test, absolute and conditional convergence, power series, uniform convergence. [6]

Module III

Matrix Algebra: Orthogonal, Hermitian, skew- Hermitian and unitary matrices, Elementary row and column transformations, rank and consistency conditions and solution of simultaneous equations, linear dependence and consistency conditions and solution of simultaneous equations, linear dependence and independence of vectors, Linear and orthogonal transformations, Eigen values and Eigen vectors, properties of Eigen values, Cayley-Hamilton theorem, reduction to normal forms, quadratic forms, reduction of quadratic forms to canonical forms, index, signature, Matrix calculus & its applications in solving differential equations. [9]

Module IV

Theory of equations- Descartes's rule of Signs. Relation between roots and coefficients of a polynomial equation, transformation of equation, reciprocal equation, symmetric function of roots, solution of cubic polynomial by Cardon's method, solution of bi-quadratic equations by Ferrari's and Descarte's method. [6]

Module V & VI

Complex variables: Introduction to complex variables. Functions of a complex variable. Limit, continuity, differentiability and analyticity of complex functions. Cauchy-Remann equations. Complex Integration, Cauchy's theorem and Cauchy's Integral formula, Morera's Theorem, Power series, Taylor's, Laurent's Theorems, Cauchy's inequality, Liouville's theorem, fundamental theorem of algebra. Calculus of residues, Contour integrals, Conformal mappings, and Bilinear Transformations. [12]

Text Books:

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008.
2. Complex Variables and applications- R.V. Churchill and J.W. Brown, 7th edition, 2004, McGraw-Hill.
3. A.D. Wunsch, Complex Variables with Applications, 3rd edition, Pearson Education, Inc.
4. M J Ablowitz and A S Fokas, Complex Variables Introduction and Applications Cambridge Texts, 2nd Ed.
5. Higher Algebra- **S Branard & J M Child**, Maxford Books (2003)
6. Introduction to Matrices and Linear Transformations: Third Edition- Daniel T. Finkbeiner, Dover Publications, 2011
7. Higher Algebra-Hall & Knight - Arihant Prakashan.

CS Data Structures (3-0-2-4)

MODULE – I [5 lectures]

Algorithms and Analysis of Algorithms: Definition, Structure and Properties of Algorithms, Development of an Algorithm, Data Structures and Algorithms, Data Structure – Definition and Classification, Efficiency of Algorithms, Apriory Analysis, Asymptotic Notations, Time Complexity of an Algorithm using O Notation, Polynomial Vs Exponential Algorithms, Average, Best and Worst case Complexities, Analyzing Recursive Programs

MODULE – II [5 lectures]

Arrays, Stacks and Queues: Array Operations, Number of Elements in an Array, Representation of Arrays in Memory, Applications of Array, Stack-Introduction, Stack Operations, Applications of Stack, Queues-Introduction, Operations on Queues, Circular Queues, Other Types of Queues, Applications of Queues.

MODULE – III [5 lectures]

Linked List, Linked Stacks and Linked Queues: Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists, Multiply Linked Lists, Applications of Linked Lists, Introduction to Linked Stack and Linked Queues, Operations on Linked Stacks and Linked Queues, Dynamic Memory Management and Linked Stack, Implementations of Linked Representations, Applications of Linked Stacks and Linked Queues.

MODULE – IV [6 lectures]

Trees, Binary Trees, BST, AVL Trees and B Trees: Trees: Definition and Basic Terminologies, Representation of Trees, Binary Trees: Basic Terminologies and Types, Representation of Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Applications, BST & AVL Trees: Introduction, BST: Definition and Operations, AVL Trees: Definition and Operations, B Trees: Introduction, m-way search trees: Definition and Operations, B Trees: Definition and Operations.

MODULE – V [5 lectures]

Sorting: Introduction, Shell Sort, Quick Sort, Heap Sort.

MODULE – VI [4 lectures]

Searching: Introduction, Binary Search, Transpose Sequential Search, Interpolation Search.

Text Book:

1. G A V Pai – Data Structures and Algorithms: Concepts, Techniques and Applications, 2nd Edn, Tata McGraw-Hill, 2008
2. Horowitz E.Sahni, S., Susan A., Fundamentals of Data Structures in C, 2nd Edition, University Press, 2010

Reference Books:

1. J. P. Tremblay , P. G. Sorenson – *An Introduction to Data Structures With Applications*, 2nd Edn, McGraw-Hill, Inc. New York, NY, USA.
2. Seymour Lipschutz – *Data Structures*, 6th Edn, 9th Reprint 2008, Tata McGraw-Hill.
3. Adam Drozdek – *Data Structures and Algorithms in C++*, Thomson Learning, New Delhi – 2007.
4. J. Feller, B. Fitzgerald -*Understanding Open Source Software Development*, Pearson Education Ltd. New Delhi

ISC Environmental Science (3-0-0-3)

Module I [6]

Introduction to Environment Pollution: Environmental Awareness, concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow biogeochemical cycle, sources, pathways and fate of environmental pollutants.

Module II [8]

Air Pollution: Composition, major sources of air pollution, their detrimental effects, stationary emission sources, some control methods, eg. cyclon separators, wet scrubbers electrostatic precipitators etc.

Automobile emission control, smog, green house effect, ozone depletion, global warming and acid rains etc.

Module III [6]

Water Pollution: Water resources, sources of water pollution, various pollutants their detrimental effects.

Portability limits as per WHO & PHED specification, treatment of municipal supply water, slow sand filters, rapid sand filter, disinfections, their advantage & disadvantages, break point chlorination.

Module IV [5]

Industrial Water: Specification for boiler feed water, internal and external treatment, ion exchange electro dialysis and revers osmosis.

Module V [5]

Sewage Treatment: Composition aerobic & anaerobic treatment, chemical & biological oxygen demand.

Module VI

A brief Introduction to Noise Pollution & Radioactive Pollution [3]

Module VII

Soil pollution and solid waste management [3]

Book Recommended:

De.A.K.Environmental Chemistry, Wiley Eastern ltd,
Miller T.G.Jr., Environmental Science, Wadsworth publishing House, Meerut
Odum.E.P.1971. Fundamental of Ecology. W.B. Saunders Co.U.S.A.

ISP 1004

Physics Lab-II

(0-0-2-1.5)

1. Determination of resistance per unit length and an unknown resistance using C. F. Bridge.
2. Determination of thermal conductivity of a bad conductor using Lee's disc method.
3. To determine the electrical equivalent of heat.
4. To determine the band gap energy of a given semiconductor by four-probe method.
5. B-H curve and hysteresis loss.
6. To study series and parallel resonant L. C. R. circuit.
7. To measure voltage and frequency of a sinusoidal waveform using a CRO and to find unknown frequencies by producing Lissajous figures.
8. To determine the emf and internal resistance of a cell using a stretched wire potentiometer.
9. (a) To study deviation of light through a prism and obtain the angle of minimum deviation using Raytrace software.
(b) To study the relationship between position of an object and its image produced by a convex lens and to find the resulting magnification.

Chemistry Lab-II (0-0-2-1.5)

1. Volumetric analysis
 - (a) Determination of acetic acid in commercial vinegar using NaOH
 - (b) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
 - (c) Estimation of hardness of water by EDTA.
 - (d) Estimation of copper using thiosulphate
2. Synthesis and analysis
 - (a) Preparation of Ni-DMG complex, $[\text{Ni}(\text{DMG})_2]$
 - (b) Gravimetric analysis of Ni as Ni-DMG complex
 - (c) Qualitative inorganic analysis of mixtures containing not more than 4 radicals from the following:
Cation Radicals: Na^+ , K^+ , Ca^{+2} , Sr^{+2} , Ba^{+2} , Al^{+3} , Cr^{+3} , Mn^{+2} , Fe^{+3} , Co^{+3} , Ni^{+3} , Cu^{+2} , Zn^{+2} .
Anion Radicals: F^- , Cl^- , Br^- , BrO_3^- , I^- , SCN^- , S^{2-} , SO_4^{2-} , $\text{S}_2\text{O}_3^{2-}$, NO_3^- , NO_2^- , PO_4^{3-} , BO_3^{3-} , CrO_4^{2-} , $\text{Cr}_2\text{O}_7^{2-}$, $\text{Fe}(\text{CN})_6^{4-}$, $\text{Fe}(\text{CN})_6^{3-}$.
Insoluble Materials: Al_2O_3 , Fe_2O_3 , Cr_2O_3 , SnO_2 , SrSO_4 , BaSO_4 , CaF_2 .
Experiment A: Preliminary Tests for acid and basic radicals in given samples.
Experiment B: Wet tests for Acid and Basic radicals in given samples.
Experiment C: Confirmatory tests.

Practical Book:

1. G. Svehla: Vogel's Qualitative Inorganic Analysis.
2. J. Mendham, R. C. Denny, J. D. Barnes, M. J. K. Thomas: Vogel's Text Book of Quantitative Chemical Analysis.
3. Vogel's Textbook of Quantitative Chemistry.
4. Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall.

Co-curricular Activity (0-0-2-1)

ISP 3001 Physics III - Modern Physics (3-0-0-3)

1. **Atomic structure:** Bohr and Sommerfeld model of hydrogen atom, Effect of finite nuclear mass, Idea of discrete energy levels and electron spin, Significance of four quantum numbers and concept of atomic orbital.
[6]
2. **Vector atom Model:**, One valence electron atom: Orbital magnetic dipole moment, Orbital, spin and total angular moment, Stern–Gerlach experiments, Larmor precession, Vector model of atom, Electronic configuration and atomic states, Spin-orbit interaction and fine structure, Intensity of spectral lines, General selection rules. Magnetic moment of the electron, Lande g factor, Zeeman Effect, Doublet structure of alkali spectra. [6]
3. **Multi electron Atom:** Pauli's exclusion principle, shell structure, Hund's rule, Atomic ground state and periodic table. [6]
4. **Molecular spectra:** The molecular bond, Electron sharing, Types of molecular energy state and molecular spectra, molecular orbital method, MO treatment of hydrogen molecule and molecular ion, diatomic molecular orbital, Molecular orbital energy level diagrams, Molecular Symmetry. [6]
5. **Special theory of relativity:** Postulates, Galilean transformations, Lorentz transformations, length contraction, time dilation, velocity addition, mass change and Einstein's mass energy relation. [6]
6. **Introduction to X-ray:** Electromagnetic radiations, continuous spectrum, characteristic spectrum, production of x-rays, detection of x-rays, properties of x-ray, safety precautions. X-ray diffraction, the Bragg law, filters. [6]

Textbooks:

Modern Physics, Arthur Beiser, Tata McGraw-Hill Edition (2008)

Modern Physics, R. A. Serway, C. J. Moses & C. A. Moyer, Thomson books (2007).

Reference books:

Richtmeyer, Kennard, Cooper

IMC 3001 Maths III - Ordinary Differential Equations with Special Functions (3-1-0-4)

Module I

Differential Equations: Linear Differential equation of 1st order. Differential Equations of first order and higher degree, Linear independence and dependence of functions. Higher order differential equations with constant coefficient, Rules of finding C.F. and P.I., Method of variation of parameter. Cauchy and Legendre's linear equations, Simultaneous linear equations with constant coefficients. [6]

Module II

Linear differential equations of second order with variable coefficients; Removal of first derivative (Normal form), Change of independent variable, Applications of higher order differential equations. [6]

Module III

Total Differential equations and conditions of integrability. Initial value problems, Existence and Uniqueness theorem. Series solution around an ordinary point and a regular singular point, the method of Frobenius. [6]

Module IV & V

Special Functions: Bessel, Legendre and Hypergeometric equations, Confluent Hypergeometric equation, Self adjoint eigen value problems, Green's functions, Second order boundary value problems, Sturm Liouville problems. [12]

Module VI

Fourier Series:

Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier series, Parseval's formula, complex form of Fourier series. [6]

Text Book:

1. Simmons G.F., Differential Equations with Applications and Historical Notes, TMH, 2nd ed., 1991.

Reference Books:

2. Dennis G. Zill, Warren S. Wright, Advanced Engineering Mathematics, 4th edition, Jones and Bartlett Publishers, 2010
3. Edwards & Penney, Differential Equations and Boundary value problems, Pearson Education, 3rd ed.
4. Shepley L. Ross, Differential Equations, Wiley India Pvt. Ltd, 3rd ed.
5. Birkhoff & Rota, Ordinary Differential Equations, Wiley India Pvt. Ltd., 4th ed.
6. Zill, Differential Equations, Thomson Learning, 5th ed., 2004

CS JAVA Programming & Web Technology (3-0-2-4)

MODULE – I

Introduction to Java Applications, Memory Concepts, Arithmetic, Decision making, Equality and Relational Operators. Introduction to Java Applets, Drawing strings and lines.

Control Statements: if, if ... else, selection statements, while statement, compound assignment operators, increment decrement operators, for ... statement, do.... While, switch, break and continue, labelled break and continue, logical operators.

Methods in java: declarations, argument promotions, scope of declarations, method overloading, Recursion.

Arrays: declaring and creating references and reference parameters, passing arrays to methods, multi dimensional arrays.

MODULE – II

Object based programming, classes, class scope, controlling access to members, this keyword and its use, constructors, overloading constructors, composition, garbage collection, static class members, final instance variables, crating packages, package access, Data abstraction and encapsulation.

MODULE – III

Inheritance and polymorphism: super class and subclass, protected members, Relation ship between super and sub class. Inheritance hierarchy, abstract classes and methods, final methods and classes, nested classes, Type wrappers.

MODULE – IV

Exception handling, Java exception hierarchy, rethrowing an exception, finally clause, stacks unwinding, chained exception, declaring new exception types.

Multithreading: Life cycle of a thread, priorities and scheduling, creating and executing threads synchronization.

MODULE – V

Files and streams, hierarchy, files and streams, File class, Sequential access file manipulation, random access file handling, Introduction to String class and its members.

MODULE – VI

World Wide Web, Client / Server architecture, Web browser, Web server, creating a web site and mark up languages, HTML, document structuring tags in HTML, Special tags in HTML.

MODULE – VII

Introduction to DHTML, scripting languages, java script: objects, methods, events & event handling, Document object model.

Text Book:

1. Dietel,Dietel - Java How to program , 5th edition; Pearson Education , New Delhi.
2. S. Raj Kamal – Inetrnet and Web Technology, Tata McGraw Hill, New Delhi, 2002.

Reference:

1. C. Horstmann,G. Cornell - Core Java 2 Vol I & Vol II ; Pearson Education , New Delhi.
2. Balagurusamy -Programming in Java, 2nd Edition; Tata McGraw Hill Publication; New Delhi.
3. Patrick Naghton & H. Schildt – The Complete Reference Java 2, Tata McGraw Hill Publication, New Delhi.

PS 1301

Biological Sciences

(3-0-0-3)

Module I

Cytology: Plant cell & its structure, Mitosis & meiosis, Different types of plant tissues & their functions. (4)

Module II

Genetics: Mendalism, Chromosomal aberration, Polyploidy. (7)

Module III

Morphology & Histology of different parts of the plants: root, stem, bark, leaf, flower, fruit, and seed. (6)

Module IV

Classification of plants: in brief. (2)

Module V

General survey of Animal Kingdom: Structure and life history of parasites as illustrated by amoeba, entamoeba, trypanosoma, plasmodium, taenia, and ascaris.
General Structure and Life History of Insects (in relation to humans & medicinal crops): Mosquito, Housefly, Mites, Tse – Tse fly, Silkworm. (7)

Module VI

General overview of Physiology and various terminologies used in physiology and pharmacology. (5)

Module VII

Cell & Tissue : Structure of cell, its components and their functions, Mechanism of Transport through the Cell membrane, (5)

Books Recommended:

1. Dutta : “Text Book of Botany,”
2. Maheshwari : “Text Book of Botany,”
3. Gupta : “Genetics,”
4. Hess : “Plant Physiology,”
5. Trueman : “Elementary Biology,”
6. Vidyarathi : “Text Book of Biology,”
7. Guyton & Hall: “Textbook of Medical Physiology,” WB Saunders Company,
8. Chatterjee: “Human Physiology,” Vols I & II, Medical Allied Agency, Calcutta,

ISP 3002 Physics Lab – III (0-0-2-1.5)

1. To study the force experienced by a current carrying conductor placed in a magnetic field (Lorentz force) using a mechanical balance.
2. Determination of boiling point of a liquid by platinum resistance thermometer.
3. Determination of wavelength of sodium yellow line by Newton's rings.
4. Determination of wavelength of mercury lines by diffraction grating.
5. To study polarization by reflection and determine Brewster's angle.
6. Determination of wavelength of sodium yellow line by Fresnel's Biprism
7. Michelson Interferometer with sodium vapour lamp.
8. To determine the slit width of a given aperture by laser diffraction method.

Chemistry Lab-III (0-0-2-1.5)

- Mixed melting point determination
 - Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)
- Decolorisation and Crystallization using Charcoal
 - Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.
 - Crystallization and decolorisation of impure naphthalene (100 g of naphthalene mixed with 0.3 g Congo Red using 1 g decolorizing carbone) from ethanol
- Sublimation (Simple and Vacuum)
Camphor, Naphtalene, Phthalic Acid and Succinic Acid
- Qualitative Analysis
 - Element detection and Functional group determination (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and aniline) in simple organic compounds and mixture analysis.
- Thin Layer Chromatography: Determination of Rf values and identification of organic compounds.
 - Separation of green leaf pigments (spinach leaves may be used).
 - Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60).
 - Separation of mixture of dyes using cyclohexane and ethyl acetate (8.5: 1.5)
- One step organic synthesis:
 - Rf determination, crystallization, melting point determination.
 - UV and IR spectroscopic analysis.

Books Suggested:

- Vogels Textbook of Practical Organic Chemistry
- Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
- Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill
- Laboratory Manual in Organic Chemistry, R. K. Bansal, Wiley.

Co-curricular Activity (0-0-2-1)

ISP 4001 Physics IV - Modern Optics (3-0-0-3)

Physical Optics

Interference: Conditions for sustained interference, Theory of interference, Two-Beam Interference, Interference in parallel and wedge shaped films, Achromatic fringes, Color of thin films. Newton's rings and Michelson interferometer and their applications. Multiple beam interference in parallel film and Fabry-Perot interferometer. [12]

Diffraction: Fresnel's diffraction, Zone plate, diffraction due to straight edge. Fraunhofer diffraction due to single and double slits, plane transmission grating and its resolving power. [6]

Polarization : Polarization of light, Malus's law, polarization by reflection, Brewster's law, Analysis of linearly and circularly polarized light, Polarization by double refraction and Huygen's theory, Nicol prism, Retardation plates, Optical activity and Fresnel's theory, Biquartz polarimeter [8]

Lasers and Holography:

Lasers: Einstein coefficients, Threshold condition for LASER action, Rate equation for three level laser system, Characteristics of laser radiation. He-Ne and Nd-YAG Laser.

Holography: Principle of holography, recording and reconstruction method and its theory as interference between two plane waves, Applications of Holography. [10]

Textbooks:

1. Jenkins and White ; Fundamentals of Optics
2. Ghatak; Optics

Reference books:

3. Hecht & Zajak; Optics
4. An introduction to Laser Theory and Application – M.N.Avdhanulu
5. Perspective of Modern Physics, A. Beiser (AB), Mc Graw Hill Int

ISC Chemistry IV (3-0-0-3)

Module I Phase Equilibrium [6]

Statement and meaning of the terms – phase, component and degree of freedom, phase equilibria of one component system – water, phase equilibria of two component system – solid equilibria, simple eutectic – Pb-Ag system, desilverisation of lead.

Module II Electrochemistry [6]

Electrical transport, Migration of ions and Kohlrausch law, Arrhenius theory of electrolytic dissociation, Application of conductivity measurements, conductometric titrations. Types of reversible electrodes Electrode reactions, Nernst equation, derivation of cell E. M. F. and single electrode potential, standard hydrogen electrode – reference electrodes, electrochemical series and its significance. Electrolytic and Galvanic cells – reversible and irreversible cells. EMF of a cell and its measurement. Potentiometric titrations.

Module III Coordination Compounds [6]

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Module IV Nuclear chemistry [5]

Radioactivity: Characteristics of radioactive decay, Decay kinetics, types of decay, α , β , γ - emissions, artificial radioactivity. Nuclear fission and fusion; Nuclear Reactors: Classification of reactors, reactor power, and application of radioactivity, nuclear waste Management.

Module V Carboxylic Acids & its derivatives [5]

Acidity of Carboxylic Acids, Effects of Substituent's on Acid Strength. Preparation and reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation, effect of heat and dehydrating agents, Mechanisms of esterification and hydrolysis (acidic and basic).

Module VI Spectroscopic Characterization of Organic Molecules [4]

Basic principles of UV-VIS and, FTIR, spectroscopy. Brief application of spectroscopic characterization of organic molecules.

Module VII Biomolecules [4]

Classifications and nomenclature of monosaccharides, Mechanism of osazone formation, Interconversion of glucose and fructose, formation of glycosides, Cyclic structure of D(+)-glucose, Mechanism of mutarotation, Classification, structure and stereochemistry of amino acids, isoelectric point, Brief introduction to peptide and proteins, Classical peptide synthesis, introduction and constituents of nucleic acids, the double helical structure of DNA.

Books Recommended :

1. Modern Electrochemistry – Vol – I & II, by **J. O. M. Bockris & A. K. N. Reddy**, Plenum.
2. Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
3. Organic Chemistry, Morrison and Boyd, Prentice Hall.
4. Concise Inorganic Chemistry by **J D Lee**, Amazon.
5. Comprehensive Co-ordination Chemistry by G. Wilkinson, R. D. Gillars & J. A. McCleverty, Pergamon
6. Principles of Bio-inorganic Chemistry by S. J. Lippard & J. M. Berg, University Science Books.

IMC 4001 Maths IV - Integral Transform & Partial Differential Equations (3-1-0-4)

Module I

Laplace Transform : Definition of Laplace Transform, Linearity property, condition for existence of Laplace Transform; First & Second Shifting properties, Laplace Transform of derivatives and integrals; Unit step functions, Dirac delta-function. Differentiation and Integration of transforms, Convolution Theorem, Inversion. Periodic functions. Evaluation of integrals by L.T., Solution of boundary value problems. [6]

Module II

Fourier Transform: Fourier Integral formula, Fourier Transform, Fourier sine and cosine transforms. Linearity, Scaling, frequency shifting and time shifting properties. Self reciprocity of Fourier Transform. Convolution theorem. Application to boundary value problems. [6]

Module III & IV

Integral Equations: Integral Equations: Basic concepts, Volterra integral equations, Relationship between linear differential equations and Volterra equations, Resolvent kernel, Method of successive approximations, Convolution type equations, Volterra equation of first kind, Abel's integral equation, Fredholm integral equations, Fredholm equations of the second kind, the method of Fredholm determinants, Iterated kernels, Integral equations with degenerate kernels, Introduction to Singular integral equations. [12]

Module V & VI

Partial Differential Equations: Formation of P.D.E, Equations solvable by direct integration, Linear and non-linear equations of first order, Lagrange's equations, and Charpit's method, Homogeneous and non-homogeneous linear P.D.E. with constant coefficients, Rules for finding C.F. & P.I. Linear and quasi linear equations, Partial Differential Equations of second order with constant and variable coefficients, Classification and reduction of second order equations to canonical form, Cauchy's, Neumann and Dirichlet's problems, Solution of Laplace and Poisson's equations in two and three dimensions by variable separable method, Solution of wave equation and unsteady heat equation in homogeneous, non-homogeneous cases. [12]

Text Books:

1. The use of integral Transforms -**I.N. Sneddon**, TATA McGraw-Hill
2. Elements of Partial Differential Equations-**I.N. Sneddon** -Dover Publications
3. Simmons G.F., Differential Equations with Applications and Historical Notes, TMH, 2nd ed.,1991.

Reference Books:

4. Zill, Differential Equations, Thomson Learning, 5th ed., 2004
5. **F H Miller**, Partial Differential Equations -- J. Wiley & Sons, Inc.
6. **F H Miller**, Partial Differential Equations -- J. Wiley & Sons, Inc.

IHU Value Education, Human Rights and Legislative Procedure (3-0-0-3)

Module I

[7]

Concept of value and value education: Social Values and Individual Attitudes, Work Ethics, Indian Vision of Humanism, Moral and Non-moral Valuation, Standards and Principles, Value Judgments.

Module II

[5]

Theories of value development: Rural Development in India, Co-operative Movement and Rural Development.

Module III

[5]

Human Rights, UN declaration, Role of various agencies in protection and promotion of rights.

Module IV

[8]

Indian Constitution: Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive, and Judiciary: Their Composition, Scope and Activities.

Module V

[11]

The Legislature: Function of Parliament, Constitution of Parliament, Composition of the Council of the States, Composition of the House of People, Speaker.

Legislative Procedure: Ordinary Bills, Money Bills, Private Member Bills; Drafting Bills; Moving the Bills, Debate, Voting, Approval of the President/Governor.

Vigilance: Lokpal and Functionaries

Books:

1. Value education and human rights: R.P.Shukla, Sarup & Sons.
2. Human Rights, Education, & Global Responsibilities, Vol 3, James Lynch, Celia Modgil, Sohan Modgil 1992, The Falmer press.
3. Human Rights, Volume 4: U.N. Gupta, Atlantic Publishers And Distributers
4. **Human rights:** an interdisciplinary approach, Michael Freeman, Wiley-Blackwell,

ISP 4003 Solid State Physics (3-1-0-4)

Crystal structure: Lattice, Basis, Translational vectors, Primitive unit cell, Symmetry operations, Bravais lattices, SC, BCC and FCC structures, Packing fraction, Miller indices, Lattice planes and directions, Reciprocal lattice; Bragg's law and Bragg's Diffraction condition in direct and reciprocal lattice, Ewald's construction, Debye Scherer method, Analysis of cubic structure by powder method. [7]

Crystal bonding: Different types of bonding- ionic, covalent, metallic, van der Waals and hydrogen bonding; cohesive energy. [3]

Lattice Vibrations: Vibration modes of continuous medium; concept of Phonons; Lattice specific heat; Classical theory, Einstein's theory and Debye's theory of specific heat. [4]

Free Electron Theory: Classical free electron theory (Drude model) and its draw back; Quantum theory of free electrons: Schrodinger's wave equations and its applications in particle in box; Physical significance of wave function; Fermi energy, Fermi level, Fermi-Dirac distribution function and effect of temperature; Hall Effect, Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator [7]

Semiconductors Introduction to Metal, Semiconductors and insulator; Types of semiconductors: intrinsic and extrinsic semiconductors; junction devices (diode, transistors, LED,).

[4]

Dielectrics: Concepts of dielectrics, Dipole moment; Basic concepts and types of polarization, A.C. effects, Ferro-electricity, Piezo electricity, Ferro and piezo electric materials. [4]

Magnetism: Electron spin and magnetic moment; Origin of magnetism; Types of Magnetism: Dia-, para-, ferro-, ferri-, and antiferromagnetism; Langevin theory of Dia- and paramagnetism, Curie's law; Magnetic domains & hysteresis, Magnetic materials, Magnetic storage devices, Memory materials [4]

Superconductivity: Introduction, effect of magnetic field, Meissner effect, Isotope effect, Penetration depth (London Equations). [3]

Text books:

1. Introduction to Solid State Physics:C. Kittel, Wiley Eastern ltd., New Delhi - 1988.
2. A. J. Dekker: Solid state Physics

Reference books:

1. Solid State Electronics Engineering Materials, S. O. Pillai, Wiley Eastern ltd. New Delhi, 1992.
2. Solid State Physics: Ashcroft & Mermin

ISP 4002 Physics Lab IV (0-0-2-1.5)

1. Study of Hall affect.
2. To study variation of magnetic field along the axis of Helmholtz Galvanometer and to determine reduction factor.
3. Febry Perot Interferometer
4. Mach-Zhender Interferometer using a He-Ne laser.
5. Determination of Planck's constant by means of LED's
6. To draw the input and output characteristics of a p-n-p transistor.
7. Solar cell experiment.
8. Determination of Stefan's constant.

Chemistry Lab IV (0-0-2-1.5)

1. To determine the cell constant of a conductivity cell.
2. To determine the molar conductivity of weak mono – basic acid over a given range of concentration.
3. To determine Pka value of the given organic acid by pH measurement.
4. Determine λ_{max} for KMnO_4 by colorimetric measurements
5. Determine the surface tension of a liquid by stalagmometer method
6. Determine the Viscosity of a given liquid by Oswald's Viscometer.
7. To study the distribution of benzoic acid between benzene and water at room temperature and hence show the molecular state of benzoic acid in benzene.
8. Determine the heat of neutralization of HCl by NaOH.
9. Study the hydrolysis of an ester in presence of HCl.

1. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.

Co-curricular Activity (0-0-2-1)

Semester-V

Organic Chemistry-II (Credit – 3-1-0)

Module I Ethers and Epoxides

Nomenclature and methods of formation, physical properties, Chemical reactions: cleavage and autoxidation, Zeisel's method. Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Module II Aldehydes and Ketones:

Synthesis of aldehydes and ketones from acid chlorides, 1,3-dithianes, nitriles and carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group: Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction, Use of acetals as protecting group. Baeyer-Villiger oxidation, Meerwein-Ponndorf Verley, Clemmensen, and NaBH₄ reductions, Halogenation of enolizable ketones, An introduction to α , β unsaturated aldehydes and ketones.

Module III Carboxylic acid and Derivatives

Preparation and Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction, Mechanisms of esterification and hydrolysis (acidic and basic). Reduction of carboxylic acids, Mechanism of decarboxylation, effect of heat and dehydrating agents, methods of formation and chemical reactions of unsaturated monocarboxylic acids, Dicarboxylic acids, haloacids, hydroxy acids- Malic, tartaric & citric acid and acid anhydrides. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Module IV Nitrogen Compounds

Preparation and Chemical reactions of nitroalkanes and nitroarenes, Mechanisms of nucleophilic Substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid. Halonitroarenes: reactivity, structure and nomenclature, physical properties, Stereochemistry of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds, Gabriel-Phthalamide reaction, Hoffmann bromamide reaction, Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

Module V Organometallic Compounds

Organomagnesium compounds: the Grignard reagents-formation, structure and chemical reactions. Organolithium compounds: formation and chemical reactions.

Module VI Organosulphur Compounds

Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine

Suggested Books:

1. **Organic Chemistry**", I. L. Finar, Vol. I & II, Longman Ltd., New Delhi.
2. **Organic Chemistry**, Morrison and Boyd, Prentice Hall.
3. **Organic reaction and mechanism-structure and reactivity** by Jerry March
4. **Introduction to Organic Chemistry**, Streitwiesser, Hathcock and Kosover, Macmillan.
5. **A Guide Book to Mechanism in Organic Chemistry**", P. Sykes, Orient Longman Ltd.
6. **Fundamentals of Organic Chemistry**, Solomons, John Wiley. **Organic Chemistry**, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford University Press, USA
7. **Organic Chemistry**, L.G. Wade Jr. Prentice Hall.
8. **Organic Chemistry**, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford University Press, USA
9. **Organic Chemistry**, L.G. Wade Jr. Prentice Hall.

Semester-V

Inorganic Chemistry –II

Credits :3-1-0

Module I: Inorganic Rings, chains and cages

Catenation and Heterocatenation, Heterocyclic Ring System- Borazines, Phosphazines- Monomer and Polymer, S-N ring compounds, Homocyclic rings of S, Se and Te. Silicates minerals, Isopolyanions, Boranes: boron cage compounds-closo, nido, arachno, carboranes; cage compounds of S and P.

Module II : Coordination Chemistry

Bonding theories: Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of $10 Dq$ (Δ_o), CFSE in weak and strong fields, pairing energies, factors effecting the magnitude of $10 Dq$ (Δ_o , Δ_t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar coordination. Ligand field and MO Theories (Elementary idea only Chelate effect, polynuclear complexes.

Module III: Isomerism in coordination compounds

Stereoisomerism: geometrical and optical, Structural isomerism: coordination, ionization, hydrate, linkage.

Module IV Electronic spectra of coordination complexes

Types of electronic transitions, selection rule for d-d transitions, spectroscopic ground states. Explanation of electronic spectra on the basis of Orgel energy level diagrams. Spectrochemical series, nephelauxetic effect,

Module V: Reaction kinetics and mechanism

The trans effect, theories of trans effect, mechanism of trans effect, kinetics of substitution reactions in square planar complexes. Thermodynamic and kinetic stability including factors affecting them. Labile and inert complexes. Electron transfer reactions, Inner sphere, outer sphere, without breaking M-L bond.

Books Recommended:

1. Basic Inorganic Chemistry by **F. A. Cotton & Wilkinson**, John Wiley
2. Inorganic Chemistry by **J. E. Huhey**, Harpes & Row
3. Comprehensive Co-ordination Chemistry by **G. Wilkinson, R. D. Gillars & J. A. McCleverty**, Pergamon
4. Concise Inorganic Chemistry by **J D Lee**.

Semester-V Inorganic Chemistry Lab: Credit:1.5 (0 -0-3)

1. Volumetric analysis
 - (a) Determination of alkali content in antacid tablet using HCl.
 - (b) Estimation of ferrous and ferric by dichromate method.
 - (c) Complexometry (EDTA): CaCO_3 and MgCO_3 in mixture / Mg^{II} and Zn^{II} in mixture.
2. Gravimetric analysis:
Analysis of Cu as CuSCN
3. Synthesis and analysis
 - (a) Preparation of copper tetraammine complex, $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$
 - (b) Preparation of cis and trans- bisoxalato diaquachromate(III) ion
 - (c) Preparation of sodium trioxalato ferrate (III), $\text{Na}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$ and determination of its composition by permanganometry
4. Ion Exchange Method
Separation and estimation of $\text{Mg}(\text{II})$ and $\text{Zn}(\text{II})$
5. Solvent extraction
Separation and estimation of $\text{Mg}(\text{II})$ and $\text{Fe}(\text{II})$

Books Recommended:

1. Vogel's Textbook of Quantitative Chemistry.
2. Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall.
3. Vogel's Text book of Macro & Semimicro Qualitative Analysis

Semester-V Organic Chemistry Lab Credits :1.5 (0-0-3)

1. Steam Distillation
 - i. Naphthalene from its suspension in water
 - ii. Clove oil from cloves
 - iii. Separation of o- and p-nitrophenols
2. Column chromatography
 - i. Separation of fluorescein and methylene blue
 - ii. Separation of leaf pigments from spinach leaves
 - iii. Resolution of racemic mixture of mandelic acid
3. Qualitative Analysis
 - i. Analysis of an organic mixture containing two solid components using water, NaHCO₃, NaOH for separation and preparation of suitable derivatives.
4. Synthesis of Organic Compounds
 - i. Acetylation of salicylic acid, aniline, glucose and hydroquinone. Benzoylation of aniline and phenol
 - ii. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol and acetone
 - iii. Aromatic electrophilic substitution
 - a. Nitration: Preparation of m-dinitrobenzen, Preparation of p-nitroacetanilide
 - b. Halogenation: Preparation of p-bromoacetanilide, Preparation of 2,4,6-tribromophenol
 - iv. Diazotization/Coupling: Preparation of methyl orange and methyl red
 - v. Oxidation: Preparation of benzoic acid from toluene
 - vi. Reduction: Preparation of aniline from nitrobenzene, Preparation of m-nitroaniline from m-dinitrobenzene.
5. Multi-step organic synthesis:
 - i. R_f determination, crystallization, melting point determination.
 - ii. Characterization understanding through UV, IR and NMR spectroscopic analysis.

Books Suggested:

1. Vogels Textbook of Practical Organic Chemistry
2. Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
3. Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill
4. Laboratory Manual in Organic Chemistry, R. K. Bansal, Wiley.

Semester- VI Physical Chemistry II (Credit- 3-1-0)

I Elementary Quantum Mechanics

Black – body radiation, Planck’s radiation law, photoelectric effect, heat capacity of solids, Bohr’s model of hydrogen atom (no derivation) and its defects, Compton effect. De Broglie hypothesis, the Heisenberg’s uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box. Schrodinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas- criteria for forming M.O, from A.O, construction of M.O’s by LCAO – H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of σ , σ^* , π , π^* orbitals and their characteristics. Hybrid orbitals – sp , sp^2 , sp^3 , calculation of coefficients of A.O.’s used in these hybrid orbitals. Introduction to valence bond model of H_2 , comparison of M.O. and V.B. models.

II Spectroscopy

Introduction: electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born- Oppenheimer approximation, degrees of freedom.

Rotational Spectrum

Diatomic molecules. Energy levels of a rigid rotor (semi- classical principles), selection rules, spectral intensity, distribution using population distribution (Maxell- Boltzmann distribution) determination of bond length, qualitative description of non- rigid rotor, isotope effect.

Vibrational Spectrum

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman Spectrum: concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

Books Recommended:

1. The Elements of Physical Chemistry, P. W. Atkins, Oxford
2. Physical Chemistry, G. M.. Barrow, McGraw Hill
3. Physical Chemistry through problems: S. K. Dogra & S. Dogra, Wiley Eastern Ltd.

Semester – VI

Physical Chemistry III

Credit 3-1-0

Module I : Electronic Spectrum

Concept to potential energy curves for bonding and antibonding Molecular orbital, qualitative description of σ and n M.O., their energy levels and the respective transition.

Module II : Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical process. Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non – radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reaction – energy transfer processes (simple examples.)

Module III: Physical Properties and Molecular Structure

Optical activity, polarization – (Clausius – Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties – paramagnetism, diamagnetism and ferromagnetics.

Module IV : Solutions, Dilute Solutions and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentrations of solutions of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, degree of dissociation and association and association of solutes.

Books Recommended:

1. Physical Chemistry, R. A. Alberty, Wiley Eastern Ltd
2. The Elements of Physical Chemistry, P. W. Atkins, Oxford
3. Physical Chemistry, G. M.. Barrow, McGraw Hill

Semester-VI

Organic Chemistry-III (Credit – 3-1-0)

Module I NMR Spectroscopy and Structure Determination

Nuclear magnetic resonance (NMR) spectroscopy:

Proton magnetic resonance (^1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone, Brief introduction to ^{13}C NMR, Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and NMR spectroscopic techniques. Gas Chromatography: Basic concepts

Module II Photochemistry

Principles of photochemistry, photochemical reactions of carbonyl compounds and olefins, Paterno-Buchi Reaction, Norrish type-I and Norrish type-II reactions.

Module III Heterocyclic Compounds

Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and sixmembered heterocycles. Preparation and reactions of Indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

Module IV Organic synthesis via enolates

Acidity of α -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis using diethyl malonate and ethyl acetoacetate, Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate, Alkylation of 1,3-dithianes. Alkylation and acylation of enamines

Module V - Introductory Pericyclic Chemistry

Concerted reaction, Molecular orbital theory, LCAO methods, bonding and anti-bonding orbitals, orbital symmetry, correlation diagram for electrocyclic reactions, Diels-Alder reaction.

Module VI Alkaloids & Terpens

Occurrence, importance, general structural features, Hofmann exhaustive methylation, structure and synthesis of nicotine and piperine. Terpenes: Occurrence, isolation, classification, Isoprene rule, structure and synthesis of citral, geraniol and α -terpineol.

Module VII Vitamins and Hormones

Chemical constitution and physiological functions of vitamins A, B2 (Riboflavin), C (Ascorbic acid); Thyroxin and estrone.

Suggested Books:

1. **Organic Chemistry**, I. L. Finar, Vol. I & II, Longman Ltd., New Delhi.
2. **Organic Chemistry**, Morrison and Boyd, Prentice Hall.
3. **Organic reaction and mechanism-structure and reactivity** by Jerry March
4. **Introduction to Organic Chemistry**, Streitwieser, Heathcock and Kosover, Macmillan.
5. **A Guide Book to Mechanism in Organic Chemistry**, P. Sykes, Orient Longman Ltd.

Semester-VI

Inorganic Chemistry -III

Credit: 4 (3-1-0)

Module I: Lanthanides and actinides

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). General features and chemistry of actinides, principles of separation of Np, Pu and Am from U. Trans-Uranium elements.

Module II: Magnetochemistry of coordination complexes

Definition of magnetic properties, types of magnetic bodies, two sources of paramagnetism: orbital and spin effects, Diamagnetism and Pascal's constant, methods of determining magnetic susceptibility, orbital contribution to magnetic moments, magnetic properties based on crystal field models: octahedral, tetrahedral, trigonal bipyramidal, square pyramidal, tetragonally distorted octahedral complexes, spin state equilibrium in octahedral stereochemistry: crossover region, Valence bond and crystal field interpretation of magnetic moments. Correlation of magnetic moment data and stereochemistry; anomalous magnetic moments.

Module III: Organometallic Chemistry

Definition and classification of organometallic compounds, EAN rule (18e and 16e), Preparation, properties, bonding and applications of alkyl and aryls of Li, Al, Hg, Sn, Ti. A brief account of metal-ethylenic complexes and homogeneous hydrogenation

Module IV: Metal carbonyls

Preparation, properties, structure and bonding of mononuclear carbonyls. π - acceptor behaviour of carbon monoxide, synergic effect (MO diagram of CO be refer for synergic effect refer to I R frequencies) Carbonylate anions, ferrocene and its reactions.

Module V : Bioinorganic Chemistry

Metal ions present in biological systems : classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump. Biochemistry of Mg and Ca Metalloenzyme oxaloacetate decarboxylase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb and As) reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Storage and transfers of iron.

Books Recommended:

1. Basic Inorganic Chemistry by **F. A. Cotton & Wilkinson**, John Wiley
2. Inorganic Chemistry by **J. E. Huhey**, Harpes & Row
3. Comprehensive Co-ordination Chemistry by **G. Wilkinson, R. D. Gillars & J. A. McCleverty**, Pergamon
4. Concise Inorganic Chemistry by **J D Lee**, Amazon.

IHU Foreign Language (German / French / etc) Language (2-0-1-3)

A. AIMS AND OBJECTIVES

1. Developing the following language skills:

LISTENING: To enable the learners to listen and understand the spoken German language which uses the elementary spoken structures.

SPEAKING: To enable the learners to speak and engage in simple dialogues in German.

READING SKILLS AND TEXTUAL COMPREHENSION: To enable the learners to read and understand the elementary texts in German.

WRITING: To enable the learners to write simple sentences and short paragraphs in German.

2. To enable the learners to manipulate the simple grammatical structures of the language and the most essential vocabulary.

3. To expose the learners to the culture of German speaking countries

D. Contents of the Syllabus

1. Simple texts and interactions useful in daily life
2. Life and culture of Germany and German speaking countries
3. Describing the immediate environment and things of common interest.

E. Functional Grammar:

1. Articles
2. Nouns and pronouns
3. Present tense
4. Position of verbs in different types of sentences
5. Direct and indirect objects
6. Interrogative sentences
7. Articles as pronouns
8. Internet sites for language skills
9. Geography of Germany and German speaking countries
10. Introduction to German culture (intercultural perspectives)

Books recommended :

1. Tangram aktuell A 1 -1, Kursbuch, Arbeitsbuch, Glossar, Übungsheft und CD Lektion 1 - 4: Deutsch als Fremdsprache, Authors: Rosa-Maria Dallapiazza, Eduard von Jan, und Til Schönherr, Verlag: Hueber.
2. Tangram aktuell A1- 2, Kursbuch, Arbeitsbuch, Glossar, Übungsheft und CD, Lektion 5 - 8: Deutsch als Fremdsprache, Authors: Rosa-Maria Dallapiazza, Eduard von Jan, und Til Schönherr, Verlag: Hueber.
3. Cassel's Language Guides: German – **A Handbook of Grammar, Current usage and word power**

VI Semester

SAC 3003: Industrial Chemistry

Credits : 3(3-0-0)

Introduction: Unit dimension, basic chemical calculations, material balances involving chemical reactions, energy balances, Stoichiometric calculation involving various processes, basic idea about functioning of various industrial equipments like heat-exchangers, economizers, boilers, catalytic converters.

Fuels and water: Importance of Solid, liquid and gaseous fuels in industry, criteria for selection of a fuel, calorific value, determination of calorific values using various instrumentation techniques, combustion calculations, solid fuel: coal, carbonization of coal, manufacturing of metallurgical coke, liquid fuel: fractionation of petroleum, thermal and catalytic cracking, LPG, producer gas. Water: Hardness of water and its removal, alkalinity and pH, Boiler feed water quality and treatment procedures, dissolve oxygen and corrosion.

Inorganic fine chemicals: manufacturing of sulfuric acid, phosphoric acid, urea, caustic soda. High performance chemicals: hydrazine and boron hydride compounds.

Pesticides and Pharmaceuticals: BHC, 2, 4-D, Parathion, Penicillin

Polymer: Manufacturing and use of PVC, Rubber, Silicones, Polyamides, Polyesters.

Metallurgical industry: Iron, Aluminum and Copper

Catalysts: General properties of catalyst, Examples of some Inorganic and polymer catalysts, use in industry.

Pollution control aspect in industry, equipments / process used for control of SO_x, fly ash, metal pollutants, organic pollutants; hazardous materials and safety aspects in industry.

References:

1. Dryden's outlines of chemical technology for 21st century, 3rd edn. (2000) M. G. Rao, M.Sittig, East-west Press, New Delhi, ISBN-81-85938-79-2.
2. Stoichiometry, 3rd Edn. B. I. Bhatt, S. M. Vora, Tata McGraw Hill, New Delhi, (1999).
3. Elementary principles of chemical processes, 3rd Edn. R. M. Felder, R. W. Rousseau, John Wiley & Sons, Inc. (2000).

Semester-VI

Physical Chemistry Lab

Credits:1.5(0-0-2)

1. To study the saponification of ethyl acetate conductometrically.
2. To determine the Ionisation constant of a weak acid conductometrically.
3. To Titrate potentiometrically the given ferrous ammonium sulphate solution using $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ as titrant and calculate redox potential of $\text{Fe}^{+2}/\text{Fe}^{+3}$ system on the hydrogen scale.
4. To determine the specific rotation of a given optically active compound.
5. Determination of Molecular wt. Of a non-volatile solute by Rast Method/ Beckmann Method.
6. To verify Beer- Lambert Law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determine the concentration of the given solution of the substance.
7. To determine the strength of the given acid conductometrically using Std. Alkali solution.
8. Investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir Isotherms.
9. Study the mutual solubility of Phenol and water at various temps and hence determine the CST.

Books Recommended

1. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.

SAC 3002: Industrial Chemistry Laboratory

Credits:1.5(0-0-2)

1. Water Quality monitoring

i.Sampling & preservation

ii.Physical Examination- pH, electrical conductivity, turbidity, colour odour,TDS,TSS,TS,

iii.Chemical Characterization: Major cations & anions,minor cations & anions,Trace & toxic chemical constituents in water

iv.Biological Investigations:BOD/COD/TOC, E-coli count

2. Air Quality Monitoring

i.Suspended particulate matter in ambient air

ii.Flue gas analysis

iii.Primary & secondary gaseous pollutants sampling & analysis

3. Soil Analysis: Determination of soil pH conductivity and salinity soil, organic carbon, nitrogen and phosphorus, sodium & potassium, CEC available sulphur.

4. Fuels :

i.Proximate analysis of coal

ii.Ultimate (Elemental analysis of coal)

iii.Calorific value determination of solid fuel

iv. Calorific value determination of gaseous fuel

v.Petrographic studies

5. Lubricants:

i.Open & closed flash point determination

ii.Aniline /cloud/ pour point determination

iii.Viscosity & Viscosity index

iv.Carbon residue

References:

1. Practical Environmental Analysis by Miroslav Radojevic and Vladimir N.Bashkin, RSC.
2. Environmental Pollution Analysis by S. M. Khopker, New Age International Corporations
3. Vogel's Textbook of Quantitative Chemistry

SAC 1003:

Organic Reaction Mechanisms

Credit: 4 (3-1-0)

1. Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

2. Stereochemistry

Conformation analysis of cycloalkanes, decalines, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups & faces, stereospecific and stereoselective synthesis. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorous.

3. Reaction Mechanisms: Structure & Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Hammond's postulate, Curtin-Hammett principle, potential energy diagrams, transition states and intermediates. Hard & soft acids, Isotope effect, Mechanism of nucleophilic substitution (S_N1 and S_N2) and elimination (E1 and E2), pKa scale, Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes, Effect of structure on reactivity – resonance and field effects, steric effect. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft-equation.

4. Free radical reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead, Reactivity in the attacking radicals, the effect of solvents on reactivity. Oxidation of aldehydes to carboxylic acids, auto-oxidation, Sandmeyer reaction, freeradical rearrangement, Hunsdieker reaction.

5. Aromatic Electrophilic and Nucleophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho / para ratio, ipso attack. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction, The S_NAr , S_N1 , benzyne and $S_{RN}1$ mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser, Smiles Rearrangement.

6. Pericyclic reactions

Molecular Orbital symmetry, Frontier orbitals of ethylene, 1, 3 – butadiene, 1, 3, 5– hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO & PMO approach. Electrocyclic reactions – conrotatory and disrotatory motions, $4n$, $4n + 2$ and allyl systems. Cycloadditions – antarafacial and suprafacial additions, $4n$ and $4n + 2$ systems, 2+2 addition of ketenes, 1, 3 dipolar cycloadditions and cheletropic reactions, Sigmatropic rearrangements- suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3, 3 – and 5, 5 – sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Ene reaction.

References:

1. Stereochemistry of Organic Chemistry by **D. Nasipuri**, New Age International.
2. Advanced Organic Chemistry – Reactions, Mechanism and Structure by **Jerry March**, John Wiley
3. Pericyclic Reactions by **S. M. Mukherjee**, Macmillan, India.
4. Enzyme Chemistry: Impact and Applications, **Ed. Collin J Suckling**, Chapman & Hall.
5. Mechanisms and Theory in Organic Chemistry, T. H. Lowry and K. H. Richardson, Harper and Row.
6. Advanced Organic Chemistry, Part A: Structure and Mechanisms, F. A. Carey and R. J. Sundberg, Springer, New York 2006.

Semester-VII

Metal Chemistry (SAC 1105) Credit: 4 (3-0-0)

Module I Chemical Bonding

5 Lectures

Variation and LCAO methods, M.O. Theory of H_2 , H_2^+ , homo and hetero-nuclear diatomic molecules of second period elements, Electron pair wave function, V.B. Theory and its application to H_2 , hybrid orbitals, localized and delocalized M.O., σ , π , δ bonds, polyatomic molecules, electron deficient and hypervalent molecules.

Module II Ligand Field Theory

8 Lectures

The concept of a Ligand field, Qualitative demonstration of ligand field effect, The physical properties affected by ligand field theory (thermochemical properties & geometric distortion, spectral properties, magnetic properties), Crystal field & Ligand Fields.

Quantitative basis of Crystal Fields: Crystal Field Theory, The octahedral Crystal Field potential, The effect of V_{oct} on the d wavefunctions, the evaluation of Δ , The tetrahedral and cubic potentials. Energy level of transition metal ions, Effect of ligands fields on the energy levels of transition metal ions.

Module III Chemistry of Non-transition Elements:

6 Lectures

General discussion on the properties of the nontransition elements; special features of individual elements; synthesis, properties and structure of their halides and oxides, polymorphism of carbon, phosphorus and sulphur. Synthesis, properties and structure of boranes, carboranes, borazines, silicates carbides, silicones, phosphazenes, sulphur –nitrogen compounds: peroxo compounds of boron, carbon and sulphur; oxy acids of nitrogen, phosphorus, sulphur and halogens, interhalogens pseudohalides and noble gas compounds.

Module IV Reaction Mechanism of Transition Metal Complexes

8 Lectures

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valency bond and crystal field theory, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, substitution reaction in square complexes, trans effect, redox reactions, electron transfer reactions, mechanism of one electron transfer reaction, outer sphere type reactions, inert sphere type reactions.

Module V Electronic Spectra of transition metal complexes

8 Lectures

Important features of transition metal electronic spectra- band intensities, band energies, band width and sets; characteristic spectra of complexes of first row transition metal ions, typical spectra of second & third row transition metal ions, Octahedral, tetrahedral and planar complexes of first row transition metal ions; spectrochemical & nephelauxetic series, charge transfer spectra. Spectroscopic ground state, Orgel and Tanabe – Sugano diagrams for transition metal complexes, calculations of D_q , B and beta parameters, Charge transfer spectra

Reference Books

1. Inorganic Chemistry – G. Wulfsberg
3. Physical Chemistry – D.A. Mcquarie & J.D. Simon
4. Molecular Orbital Theory – C.J. Ballhausen & H.B. Gray
5. Ligand Field Theory – B.N. Figgis
6. Electronic Structure and Properties of transition metal compounds – I.B. Bersuker
7. Ligand Field Theory – C.J. Ballhausen
8. Electronic Absorption Spectroscopy – D.N. Satyanarayana
9. Inorganic Electronic Spectroscopy – A.B.P. Lever
10. Inorganic Reaction Mechanism – F. Basalo & R.G. Pearson
11. Inorganic Reaction Mechanism – R.B. Jordan

Semester: VII

Environmental Chemistry SAC 1009

Credit: 3 (3-0-0)

1. Principles of Environmental Chemistry :

Role, importance and scope of environmental chemistry, multidisciplinary nature Concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow, biogeochemical cycles, sources, pathways and fate of environmental pollutants-Environmental transformation & degradation processes

2. Atmospheric Chemistry:

Chemical composition of the earth's atmosphere, units for expressing atmospheric concentration

Various segments of atmosphere & their significance, sources and toxic effects of air pollutants, Stratospheric Chemistry- Ozone, formation & turnover of ozone, processes for catalytic decomposition of ozone, chlorofluorocarbons, arctic & Antarctic ozone hole formation.

Tropospheric Chemistry- Smog, Phototransformation, types of hydrocarbon in the troposphere, reaction of organic compounds in the atmosphere .Chemistry of photochemical smog, emissions from internal combustion engine and control measures , sulfurous smog & emissions from stationary sources and control measures

Tropospheric Chemistry – Precipitation .acid rains, sources & sinks.

Atmospheric Aerosols: Sources of aerosols, aerosol concentrations & life times, PM -2.5 & its significance, control of particulate emissions

The chemistry of global climate : energy balance & the earth's atmosphere, greenhouse gases & global warming

3. Aquatic Chemistry

The Hydrosphere: physical & chemical properties of water, concentration units used for aqueous solutions

Water resources, Chemistry of natural waters, physico-chemical properties of water, Water pollution: Deoxygenating substances, influence of chemical process on dissolved oxygen, sources of water pollution, various pollutants their detrimental effects.

Portability limits as per WHO & PHED specification, treatment of municipal supply water, slow sand filters, rapid sand filter, disinfections, their advantage & disadvantages, break point chlorination, Commonly used water purification techniques

4. Soil Chemistry

Soil formation: Physical weathering ,chemical weathering,Composition of soil, micro and macro nutrients,

Physical & chemical properties of soil. Sources and chemical nature of soil contaminants, Distribution of soil contaminants: Soil –water partition process, soil- organism processes, Ecological and health effects of soil contaminants.

6. Chemistry of Solid wastes

Sources, Classification and composition of MSW, Properties of MSW, MSW management, Waste minimization, Life cycle assessment, benefits, waste reduction techniques, Reuse and recycling, Biological MSW treatment, Thermal treatment, Landfill, Integrated waste management.

Radiation hazards: Types of radiation, sources, effects, control and disposal of nuclear waste.

Books recommended:

1. Environmental Chemistry : a global perspective, G.W.vanLoon, S.J. Duffy, Oxford publication
2. Practical Environmental Analysis by Miroslav Radojevic and Vladimir N. Bashkin, RSC.
3. An Introduction to Environmental Science & Engineering by Gilbert M. Masters.

SAC 1002: Computational Chemistry Lab Credit: 1.5 (1-0-2)

Object: This syllabus is designed to provide a preliminary idea with experimentation about the Computational Chemistry/Molecular Modeling and their application.

1. Computer Fundamentals (Operating Systems e.g. MSDOS, Windows, LINUX).
2. Introduction and application about the computational chemistry & molecular modeling software.
3. Understanding of the chemical structure and physico-chemical properties using chemistry software "ChemOffice Ultra"
 - a) Draw a chemical structure and reactions with the example of organic and inorganic substances along with physical notations such as bonding, enthalpy, entropy, etc.
 - b) Concept, application and handling of 2D & 3D structure. Draw the structures of biological active molecules.
4. Understand the concept of stereochemistry and draw the stereochemical structure by using the example of nucleoside and amino acid.
5. Minimization of the chemical structure with the example of nucleoside.
6. Compute the structural and physico-chemical properties (e.g.; bond length, bond angle, dihedral angle, conformation, partial charge, steric energy, etc.) of the target molecule using ChemDraw Tools.

Reference Books:

1. Introduction to theory & application of molecular and quantum mechanics, Errol Lewars, (Springer)
2. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...
by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale

Semester: VII SAC 1004: Organic Chemistry Lab Credit: 1.5 (0-0-3)

A. Qualitative Analysis

Identification of organic compounds (solid and liquid) using chemical analysis and preparation of their suitable derivatives

Separation, Purification and identification of compounds of binary / tertiary mixtures (one liquid and one solid) using TLC, Paper and Column chromatography, chemical tests, IR spectra.

B. Organic Synthesis (any two)

- i) Aldol Condensation
 - ii) Sand Mayer Reaction
 - iii) Acetoacetic ester condensation
- Cannizaro reaction

C. Multistep Synthesis (any one)

- i) Photochemical reaction – Benzophenone to Benzpinacol to Benzpinacolone
- ii) Beckmann Rearrangement – Benzanilidine from Benzene
- iii) Synthesis of heterocyclic compounds – Skraup Synthesis
- iv) Enzymatic synthesis – (a) Enzymatic reduction
(b) Biosynthesis of ethanol from sucrose
- v) Synthesis of Binol from β -naphthol.

D. Extraction of Organic compounds from natural sources (any two)

- i) Isolation of caffeine from Tea leaves.
- ii) Isolation Casein from Milk
- iii) Isolation of Nicotine as dipicrate from tobacco.
- iv) Isolation of β -carotenes from carrots.

E. Quantitative analysis (any two)

- i) Determination of the percentage or number of hydroxyl groups in inorganic compounds by acetylation method.
- ii) Estimation of amines/phenols using bromate/bromite solution or Acylation method
- iii) Determination of iodine and saponification value of an oil sample.
- iv) Estimation of Glucose.
- v) Estimation of nitrogen by Kjeldahl analysis.
- vi) Estimation of carbonyl group using 2, 4 – DNP.

1. Vogel's Text book of Practical Organic Chemistry
2. Hand book of Organic Chemistry, Qualitative & Quantitative by H. Clark, Adward-Arnold
3. Systematic Qualitative Organic Analysis by H. Middleton, Adward-Arnold

Semester-VIII SAC 2001:

Theoretical Chemistry Credit: 3-0-0

1. Quantum Chemistry

Planck's quantum theory, wave – particle duality. Uncertainty Principle, operators and commutation relations; postulates of quantum mechanics and Schrodinger equation; free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator and the hydrogen atom, The variation method and perturbation theory: Application to the helium atom, antisymmetry and Exclusion Principle, Terms symbols and spectroscopic states. Born – Oppenheimer approximation, Hydrogen molecule ion. LCAO – MO and VB treatments of the hydrogen molecule; electron density, forces and their role in chemical binding. Hybridization and valence MOT of H₂O, NH₃ and CH₄. Huckel pi-electron theory and its applications to ethylene, butadiene and benzene. Idea of self-consistent field methods.

2. Symmetry & Group theory

Symmetry elements & symmetry operation, Definition of group, sub-group, relation between order of a finite group and its sub-group, classes, Point symmetry group, representation of groups by matrices, character of the representation, The great orthogonality theorem (without proof), its importance, character tables & their use.

3. Statistical Thermodynamics

Concept of distribution, Thermodynamic probability, Ensemble averaging, Canonical, grand canonical and micro canonical ensembles, Partition functions: Translational, rotational, Vibrational and electronic and calculation of thermodynamic properties, Applications Heat capacity behaviour of solids: Chemical Equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, Distribution law and applications to metals, Bose-Einstein statistics- distribution law and application to helium.

4. Non-equilibrium thermodynamics

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for irreversible processes, non-equilibrium stationary states, electrokinetic phenomena, electric conduction, irreversible thermodynamics for biological systems, coupled reactions.

References:

1. Quantum Chemistry by **Ira. N. Levine**, Prentice Hall
2. Modern Quantum Chemistry by **N. S. Ostlund & A. Szabo**, McGraw Hill
3. Methods of Molecular Quantum Mechanics by **R. Mcweeny & B. T. Sutcliffe**, Academic Press
4. Density functional Theory of Atoms and Molecules by **R. G. Parr & W. Yang**, Oxford.
5. Theoretical Chemistry, S. Glasstone, ELBS
6. Symmetry and group theory, F. A. Cotton, Wiley.

SAC 2003: Synthetic Organic Chemistry Credit: 4 (3-1-0)

Reagents of Synthetic Importance

Principle, preparations, properties and applications of the following reagents in organic synthesis with Mechanistic details: Group – I & II metal organic compounds-Li, M, Hg, Cd, Zn & Ce compounds. Transition metals – Cu, Pd, Ni, Fe, Co, Rh, Cr & Ti compounds.

Rearrangements General Mechanistic considerations – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: Pinacol-pinacolone, Wagner-Meerwein, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis

Metalloenes, Nonbenzenoid Aromatics and Polycyclic Aromatic Compounds

General considerations, synthesis and reactions of some representative compounds.

Heterocyclic Chemistry

Heterocyclic synthesis: Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions. Benzo-Fused Five - Membered Heterocycles: Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes. Six Membered Heterocycles: Synthesis and reactions of pyrylium salts, pyrones, quinolizium and benzopyrylium salts, coumarins and chromones, diazines, triazines, tetrazenes and thiazines.

Two group C-C disconnections

Diels-Alder reaction, 1, 3-difunctionalised compounds, α , β -unsaturated carbonyl compounds, control in carbonyl condensation, 1, 5-difunctionalised compounds. Michael addition and Robinson annelation, Retrosynthetic analysis, Concept of umpolung Concept of synthetic efficiency: one pot, multi-step, multi-component and atom economical reactions.

Ring synthesis

Saturated heterocycles, synthesis of 3-, 4-, 5- and 6 membered rings, aromatic heterocycles in organic synthesis

Synthesis of Some Complex Molecules

Reserpine, Vitamin – D, Chlorophyll, Quinine, Morphine, α -terpinol, Estrone, Biosynthesis of steroid

References:

1. Some modern methods of Organic Synthesis by **W. Carruthers**, Cambridge Univ. Press.
2. Advanced Organic Chemistry: Reactions, Mechanisms and Structure by **J. March**, Wiley.
3. Principles of Organic Synthesis by **R. Norman and J. M. Coxon**, Blackie Academia & Professional.
4. Modern Synthetic Reactions by **H. O. House and W. A. Benjamin**.
5. Organic Chemistry, Vol. 2, **I. L. Finar**, ELBS.
6. Natural Products: Chemistry and Biological Significance by **J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthrope and J. B. Harborne**, Longman, Essex.
7. Advanced Organic Chemistry, Part B: Reactions and Synthesis, F. A. Carey and R. J. Sundberg, Springer, New York 2006.

SAC 2005: Advanced Analytical Techniques

Credit: 3 (3-0-0)

1. Scope of analytical sciences:

Basic tools and operations, data handling and reliability of analytical tools, sampling and methodologies, introduction to Chemometrics, Review of the current and developing methods available for collection, assessment and storage of data generated from analytical equipment, GLP. Data Analysis: Types of errors, propagation of errors, accuracy and precision, least-squares analysis, average standard deviation.

2. Atomic spectroscopy:

Atomic absorption spectrophotometer: Theory, Instrumentation and applications in environmental sample analysis, back-ground correction, X-ray fluorescence spectroscopy.

3. Thermoanalytical technique:

Theory, instrumentation and applications of TGA, DTA, DSC.

4. Electrochemical techniques:

Electro-chemical instrumentation: coulometry, polarography, Cyclic voltametry: Theory, Instrumentation and applications in oxidation, reduction reactions, pulse technique and stripping voltametry

5. An introduction to surface characterization techniques:

SEM, XRD

6. Principle and application of Chromatography:

Classification of stationary and mobile phase, Principle of detection methods, Thin Layer Chromatography, HPTLC, Chromatography Paper Chromatography and Column Chromatography: Gravity, Flash and Vacuum, HPLC/UPLC, LC-MS/MS, Preparative Column Chromatography GC, GC-MS/MS, Gel Chromatography, GPC, Electrophoresis

Reference Books

1. Christian, G. D., Analytical Chemistry, 6th edition, John Wiley & Sons
2. Kealey, D. & Haines, P. J., Analytical Chemistry, Viva Books Pvt. Ltd.
3. Khopkar, S. M., Basic Concepts of Analytical Chemistry, 2nd edition, New Age Int. Pvt. Ltd.

Semester-VIII Advanced Inorganic Chemistry (SAC 2011) Credit: 4 (3-1-0)

Module I Magnetochemistry

Definition of magnetic properties, Types of magnetic bodies, Experimental arrangements for the determination of magnetic susceptibility: Guoy method, Faraday method, Vibrating sample magnetometer, SQUID, NMR method; Diamagnetism in atoms and polynuclear systems, Pascals constant, Two sources of paramagnetism: Spin & Orbital effects, Spin orbit coupling, Lande interval rule, Energies of J levels, Curie equation, Curie & Curie – Weiss law, Temperature independent paramagnetism, Simplification & application of Van Vleck susceptibility equation, Magnetic behaviour of lanthanides & actinides, Low spin – high spin cross over, Anomalous magnetic moments, magnetic properties of binuclear and polynuclear complexes—ferromagnetism and anti-ferromagnetism

Module II Nuclear Chemistry:

Radioactive decay and equilibrium. Nuclear reactions; Q value, cross sections, types of reactions, Chemical effects of nuclear transformations; fission and fusion, fission products and fission yields. Radioactive techniques; tracer technique, neutron activation analysis, counting techniques such as G.M. ionization and proportional counter.

Module III Crystal defects and Non-stoichiometry in solids:

Perfect and Imperfect Crystals, intrinsic and extrinsic defects- Point defects, line and plane defects, Vacancies- Schottky and Frenkel defects. Thermodynamics of Schottky and Frenkel defects formation, Colour centres, Non-stoichiometry and defects.

Module IV Electronic Properties & Band Theory in Solids:

Evolution of band structure, Brillouin zone, Effective mass of electron, Occupation of bands by electrons, Intrinsic semiconductors, Concept of hole, Extrinsic semiconductors, Hall effect, Electrical conductivity of metals, alloys & semiconductors, Fermi levels in metals & semiconductors, Direct & indirect band gap semiconductors, Photo-conductivity, Properties of junctions: metal – metal, metal – semiconductor & semiconductor – semiconductor.

Module V Solid State Reactions

Thermal decomposition reactions - Type I, Type II, Polymorphism, Enantiotropy & Monotropy, Order-disorder transitions, Buerger's Classification, Polytypism, Sintering, Zone refining, Crystal growth, Growth from solutions, Flame fusion method, Vapour deposition technique, Chemical transport reaction, Growth by condensation.

Reference Books

1. Advanced Inorganic Chemistry: F. A. Cotton & Wilkinson
2. Inorganic Chemistry: J. E. Huhey
3. Comprehensive Co-ordination Chemistry : G. Wilkinson, R. D. Gillars & J. A. McCleverty
4. Concise Inorganic Chemistry: J D Lee, Amazon.
5. . Essentials of Nuclear Chemistry:H. J. Arnikaar, 4th Edition Wiley Eastern (1987).
- 6.. Chemical Applications of Radioisotopes: H. J. M. Bowen. Buttler and Tanner (1969).
7. Introduction of Nuclear and Radiochemistry: G Friedlander, T. W. Kennedy, E. S. Macias and J. M. Miller, 3rd Edition, John Wiley (1981).
8. Elements of Magnetochemistry: R. L. Dutta, A. Syamal
9. Magnetochemistry: F.E. Mabbs and D.J. Machine
10. Introduction to Solids: LV Azaroff
11. Electronic Properties of Materials: R.E. Hummel

SAC 2009: Environmental Monitoring & Control

Credit: 3 (3-0-0)

1. Ecology & Environment

Basic concepts of ecology & ecosystem, Structure and function of an ecosystem, Energy & Nutrient flow, Segments of environment, Environmental factors, Environmental transformation and degradation processes.

2. Air pollution monitoring and control

Sampling and analysis of air pollutants, Units of pollutants, emission standards from industrial sources, control of air pollutants from mobile and stationary emission sources, Various control methods for particulate emission: gravitational settling chambers, cyclone separators, baghouse filters, electrostatic precipitators and wet scrubbers. Control of gaseous emissions, absorption by liquids, adsorption by solids, combustion. Control of Sox, NO_x, CO, Hydrocarbons from mobile and stationary emission sources. Indoor air quality

3. Water quality and control

Municipal and industrial water quality, Drinking water standards-PHED and WHO, Sampling techniques and preservation of samples, Physical examination, chemical characterization and Biological investigation, Control measures: Primary, secondary and advanced treatments, Coagulation, flocculation, sedimentation, Industrial water treatment: softening, corrosion and scale prevention

4. Soil pollution

Soil Pollution: Analysis of micro and macro nutrients in soil, Trace element analysis, pesticide analysis

5. Radiation, Noise and Odour: Measurement and control

Radiation hazards: Types of radiation, sources, effects, control and disposal of nuclear waste. Noise: Sources of Noise, types of noise, noise measurement, mapping, Control measures-Anechoic chambers, Industrial noise abatement measures, Sources of odour, sampling, measurement

6. Solid waste management

Sources, Classification and composition of MSW, Properties of MSW, MSW management, Waste minimization, Life cycle assessment, benefits, waste reduction techniques, Reuse and recycling, Biological MSW treatment, Thermal treatment, Landfill, Integrated waste management, Case studies

Books recommended:

1. Environmental Pollution Control Engineering by C.S. Rao.
2. Practical Environmental Analysis by Miroslav Radojevic and Vladimir N. Bashkin, RSC.
3. Environmental Pollution Analysis by S. M. Khopker, New Age International Corporations.
4. An Introduction to Environmental Science & Engineering by Gilbert M. Masters.
5. Chemical analysis of ecological materials by S. E. Allen.

SAC 2002: Inorganic Chemistry Lab Credit: 1.5 (0-0-3)

1. Qualitative Semi-microanalysis:

Qualitative semi microanalysis of inorganic mixtures containing 6-8 radicals including interfering radicals and less common metal ions such as Mo, W, Ti, Zr, Th, V and U (Cationic/anionic form).

2. **Qualitative analysis of hematite** by KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$.

3. **Quantitative analysis of alloys** (Brass or gun metal), steel using conventional chemical analysis and physical techniques.

4. **Qualitative analysis** of cement using conventional chemical analysis and physical techniques.

5. Estimation of the following (ANY One)

(a) Mg by EDTA method (b) Zn by potassium ferrocyanide (c) Ni by dimethyl glyoxime (DMG)
(d) Manganese and steel by Sodium bismuthate method.

6. **Preparation of the following complexes and their studies (ANY ONE)** by IR, electronic spectra and Magnetic susceptibility measurement

(a) Hexamine cobaltic chloride (b) Sodium Nitroprusside (c) Potassium trioxalato chromate (d) Prussian Blue. (e) Nickel dimethyl glyoxime.

7. **Preparation of (ANY ONE) Co (III)/Cr (III) complexes**, their purification, molecular weight determination and elucidation of the structures.

(a) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$

(b) $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$

(c) $[\text{Cr}(\text{H}_2\text{O})_6]\text{NO}_3 \cdot \text{H}_2\text{O}$

(d) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot \text{H}_2\text{O}$

8. **Determination of Mn/Cr/V** in steel sample by spectrophotometric method.

References:

1. Vogel's Textbook of Quantitative Chemistry.

2. Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall.

3. Vogel's Text book of Macro & Semi-micro Qualitative Analysis.

SAC 2004: Physical Chemistry LAB

Credit: 1.5 (0-0-3)

A. Error analysis and statistical data analysis

B. Adsorption: (any two)

- (i) to study surface tension-concentration relationship for solutions
- (ii) To study the adsorption of iodine from alcoholic solution of charcoal.
- (iii) To study the adsorption of acetic acid on charcoal

C. Chemical equilibrium : (any one)

- (i) Determination of congruent composition & temperature of a binary system – Phenol-water
- (ii) Determination of glass transition temperature of a given salt conductometrically
- (iii) To construct the phase diagram for a three component systems.
- (iv) to determine the equilibrium constant for the reaction $KI + I_2 = KI_3$.

D. Chemical Kinetics: (any two)

- (i) Determination of rate constant of saponification ethyl acetate by NaOH
- (ii) Determination of the effect of change of temperature, concentration of reactant and catalyst and ionic strength of the media on the velocity constant of hydrolysis of an ester
- (iii) Determination of the velocity constant of hydrolysis of an ester in micellar media.
- (iv) Determination of the rate constant for the oxidation of iodide ion by hydrogen peroxide, studying the kinetics as an iodine clock reaction
- (v) Oscillatory reaction: Chemical oscillation & pattern formation in B-Z system.

E. Electrochemistry:

Conductometry: (any two)

- I. Determination of velocity constant, order of reaction and energy of activation for saponification of ethyl acetate by NaOH conductometrically.
- II. Determination of solubility and solubility product of sparingly soluble salt conductometrically.
- III. Determination of the strength of strong and weak acids in a given mixture conductometrically.
- IV. Determination activity co-efficient of zinc ions in the solution of 0.002 M $ZnSO_4$ using Debye-Huckel's limiting law.

Potentiometry-pH metry: (any one)

- I. Determination of strengths of halides in a mixture potentiometrically.
- II. Determination of valency of mercurous ions potentiometrically. Determination of the strength of strong and weak acids in a given mixture using a potentiometer-pH meter.
- III. Determination of temperature dependence of e.m.f of a cell.

- (v) Acid-base titration in a non-aqueous media using a pH meter.
- (vi) Determination of transport number by Hittrof's method.

Cyclic voltametry: **(any one)**

- (i) To find the redox potential of the given sample using cyclic voltametry.

Polarography: **(one one)**

- (i) Determination of DO in aqueous solution of organic solvent

- (iii) Determination of half way potential of Cd & Zn

EMF:

- (iv) Determination of single electrode potential of Cu/Cu²⁺

- (v) Potentiometric titration of a redox system

- (vi) Determination of e.m.f of concentration cell.

F. Polarimetry: **(any one)**

- (i) Determination of rate constant for hydrolysis/inversion of sugar using a Polarimeter

- (ii) Enzyme kinetics-inversion of sucrose.

G. Spectroscopy: **(any one)**

- (i) Determination of pK_a of an indicator in aqueous and micellar medium

- (ii) Determination of Stoichiometry and stability constant of inorganic (ferric-salicylic acid) and organic (amine-iodine) complexes

H. Thermo chemistry: **(any one)**

- (i) to determine the enthalpy of neutralization of hydrochloric acid with NaOH

- (ii) Enthalpy of combustion of benzoic acid using DSC.

References:

1. Practical Physical chemistry, Ed. B. P. Lebitte, Longman
2. Practical Physical Chemistry by A. M. James & F. E. Prichard, Longman.

Semester-IX Bio Inorganic & Organo -Metallic Chemistry SAC 3001 Credit: 4 (3-1-0)

Module I Basic Bio-inorganic Chemistry

Elements of life, the natural selection of elements, metallo-biomolecules– enzymes and proteins, their differences, Metal ion storage and transport : Ferritin, metallothioneins, ceruloplasmin; Siderophores – enterobactin, transferrin; Natural Oxygen carriers : Hemoglobin, Hemocyanin, Hemerythrin– model compounds. Hydrolytic enzyme : Carboxypeptidase A, Redox enzyme : Blue Copper protein.

Module II Model Systems in Bioinorganic Chemistry

Oxygen

management : Super oxide dismutase, catalase, peroxidase, cytochrome P – 450. Chemistry of Vitamin B₁₂, Iron – Sulphur proteins, Cytochrome, Nitrogenase- biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidences, other nitrogenase model systems, metal complexes in transmission of energy, chlorophylls, Photosystem I and II in cleavage of water- Model systems; Na⁺, K⁺ pump, Ca²⁺ transport, Hydrogenase.

Module III Structure and bonding in Organometallic chemistry

Introduction, Classical and non-classically bonded organometallic compounds, Metal-olefin complexes, Ziese's salt – modes of bonding, Non-conjugated and conjugated polenyl complexes and their bonding models specially allyl derivatives, Metal complexes of delocalized carbocycles, Metallocenes and metal arenes, Ferrocene, ruthenocene – structure and bonding, reactions. Multidecker compounds. Fluxional behavior of organometallic compounds. Transition metal carbene complexes, oxidative addition and migration (Insertion reaction).

Reference Books

1. Bioinorganic Chemistry: Bertini, Gray, Lippard, Valentine
2. Bioinorganic Chemistry: A Second Short Course: Rosette M. Roat-malone
3. Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: An Introduction and Guide: Wolfgang Kaim, Brigitte Schwederski
4. The Structure & Properties of Materials – J. Wulff & Wiley, Vol – IV
5. Electronic Structure and Properties of transition metal compounds – I.B. Bersuk
6. The Organometallic Chemistry of the Transition Metals, 4th Edn.: Robert H Crabtree
7. Organometallic Chemistry: B- M. Bochmann (Oxford series)
8. Organometallic Chemistry: R. C. Mehrotra & A. Singh
9. Fluxanol Organometallic and Coordination compounds: Marcel Gielen, Rudolf Willem, Bernd Wrackmeyer

SAC 3005-Advance Organic Chemistry Credit : 4 (3-1-0)

1. Oxidation

Alkyl Oxidation (SeO₂, CrO₃, CrO₂Cl₂, LTA, *t*-BuOOH, MCPBA), Alkene oxidation (CrO₂Cl₂, LTA, PdCl₂, HgSO₄, KMnO₄, OsO₄, epoxidation), Carbonyl oxidation (C₆H₅CO₃H, RCO₃H, CF₃CO₃H, I₂/Py, HIO₄), Alcohol oxidation (CrO₃, PCC, PDC, Des-Martin periodinane, IBX, NBS, MnO₂, AgNO₃, Ag₂CO₃, Ag₂O, AgO), Nitro oxidation by KMnO₄, Amino oxidation (KMnO₄, H₂O₂, MnO₂, cyano (H₂O₂), Oxidative bond cleavage (KMnO₄, NaIO₄ cat. OsO₄/RuO₄, Ozone, LTA), Dehydrogenation (DDQ, DDQ/PbO₂, LTA, SeO₂).

2. Reduction

Catalytic hydrogenation and hydrogenolysis of various functional groups by Pt₂O, Pd/C, raney nickel, Homogeneous hydrogenation by transition metal complexes {Rh, Ru}, Metal hydrides {LiAlH₄, alkoxyaluminate, DIBAL-H, NaBH₄, NaBH₃CN, LiBH₄, Zn(BH₄)₂, NaBH₄/CeCl₃, alkoxy/alkyl borohydrides, super-hydride, selectrides, *n*-Bu₃SnH}, dissolving metal {Li, Na in Liq. NH₃, Zn/HCl or CH₃COOH}, non-metallic reducing agent {hydrazine, Et₃SiH, Ph₂SiH₂, formic acid}, Enzymatic and microbial reductions.

3. Organic Photochemistry

Singlet and triplet excited state, radiative and radiationless transition, potential energy surfaces, photoreduction, photoaddition, photorearrangement, photooxidation, aromatic substitution, photolysis (Norrish Type I), fragmentation (Norrish Type II), excimers and exciplexes, photochemistry of alkenes, carbonyl, aromatic compounds

4. Asymmetric synthesis

Preg's rule, Cram's rule, Karabatsos's rule, Felkin's rule and their application in organic synthesis, enzymatic and catalytic asymmetric synthesis, stereoselectivity in hydride reduction.

5. Selected Name Reactions

Sharpless asymmetric epoxidation and dihydroxylation, hydroxylations, Peterson's olefications, Robinson annelation, Barton reaction, Mukayama-aldol reaction, Evan's aldol reaction, Swern oxidation, Moffatt oxidation, Williamson ether synthesis, Prevost reaction, Oppenauer oxidation, Rosenmund reduction, Metathesis reactions, Wittig reaction, Click Reaction, McMurry olefination, Suzuki, Heck and Sonogashira coupling, Mitsunobu reaction, Nef reaction,

Reference:

1. Some modern methods of organic synthesis – W. Carruthers
2. Advanced organic chemistry – F. A. Carey and R. J. Sundberg
3. Principle of Organic Synthesis – R. O. C. Norman and J. M. Coxon
4. Named Organic reactions – T. Laue, A. Plagens
5. Organic reaction mechanism – V. K. Ahluwalia, R. K. Parashar
6. Organic synthesis- Michael B. Smith

SAC 3004: Advanced Characterization Lab Credit : 1.5 (0-0-3)

I: Examples of organic sample characterization by UV-VIS, IR, NMR, Mass, CHN, mp and single crystal diffraction techniques.

Experiment 1: Synthesis and characterization of sugar intermediates using UV, IR, NMR (^1H and ^{13}C), Mass, mp and CHN.

Experiment 2: Synthesis of Nucleo-base analogs and characterization using UV, IR, NMR (^1H and ^{13}C), Mass, mp and CHN.

Experiment 3: Synthesis of Benzanilide and characterization using UV, IR, NMR (^1H and ^{13}C), Mass, mp and CHN.

II: Examples of bimolecular and polymeric materials characterization using Intense Viscosity Measurement, Molecular Weight Determination and Distribution using GPC, Light Scattering Technique, FTIR, NMR, SEM, XRD

Experiment 1: Determination of T_g and T_m of Polyvinyl chloride and methylmethacrylate polymer using TGA/DSC.

Experiment 2: Study of surface morphology of polymeric material /hybrid materials using XRD and SEM.

Experiment 3: Finding out molecular weight of PMMA using light-scattering/GPC.

III: Examples of inorganic sample characterization

Experiment 1: Thermogravimetric analysis of $\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$

Experiment 2: Synthesis & characterization of Fluorescent Zn complexes by spectrofluoremeter.

Experiment 3: Study of surface morphology of inorganic materials using XRD and SEM.

List of Electives

1. Modern Spectroscopy
2. Polymeric Chemistry
3. Medicinal Chemistry
4. Computational Chemistry & drug design
5. Environmental Toxicology
6. Surface Chemistry
7. Energy
8. Fuel Chemistry
9. Biomaterials

Elective

SAC 1007: Modern Spectroscopy

Credit: 3 (3-0-0)

1. Unifying Principles

Electromagnetic radiation, Interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering, Uncertainty relation and natural line width & broadening, Transition probability, Time dependent perturbation theory, transition moments, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, Vibrational and electronic energy level.

Microwave Spectroscopy

Classification of molecules, Rigid-rotor model, effect of isotopic substitution on transition frequency, intensities, non-rigid rotor, Stark effect, nuclear & electron spin interaction and effect of external field, Applications.

Vibrational Spectroscopy

Infrared Spectroscopy: Vibrational energies of diatomic molecule, zero point energy, force constant & bond strength, Morse potential energy diagram, Vibration, rotation spectroscopy, vibrations of polyatomic molecules, selection rules, normal modes of vibrations, Group frequencies, overtones, hot bands, factors affecting band positions and intensities, far IR region, Metal ligand vibration. Raman spectroscopy: Classical & quantum theories of Raman Effect, Pure rotational, Vibrational and Vibrational-rotational Raman spectra, selection rules, mutual exclusion principles.

Electronic Spectroscopy

Molecular spectroscopy: Energy levels, Molecular orbitals, electronic spectra of polyatomic molecules,

Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance Spectroscopy: Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurement, factors influencing chemical shifts, deshielding, spin-spin interaction, factors influencing coupling constant J, spin decoupling.

References:

1. Modern Spectroscopy by J. M. Hollas, John Wiley
2. Introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill.
3. Basic Principles of Spectroscopy by R. Chang, McGraw Hill.
4. Applied Electron Spectroscopy for Chemical Analysis by H. Windawi & F. L. Ho, Wiley Interscience.
5. Organic Spectroscopy, W. Kemp, ELBS
6. Spectroscopic methods in Organic Chemistry, D. H. Williams and I. Fleming, McGraw Hill.
7. Molecular spectroscopy, C. N. Banwell, TMH publications.

Elective

SAC 3007: Polymer Chemistry

1. Macromolecules

Polymer, Types of polymers-electrically conducting, fire resistant, liquid crystal polymers, Molecular mass, number & mass average molecular mass, Molecular mass determination (Osmometry, Viscometry, Diffusion & Light scattering method), Sedimentation, Chain configuration of macromolecules, Calculation of average dimensions of various chain structures.

2. Polymers:

Importance of polymers, Basic concepts: monomers, repeat units, degree of polymerization, linear, branched and network polymers, classification of polymers, polymerization: condensation, addition and free radical chain-ionic and coordination and co-polymerization, polymerization conditions and polymer reactions; Kinetics & mechanism of polymerization in homogenous and heterogeneous systems.

3. Polymer characterization:

Polydispersion and molecular weight concept, number average, weight average and viscosity average molecular weights, polydispersity and molecular weight distribution, The practical significance of molecular weight, measurement of molecular weights, end group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers, chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, microscopy, Thermal analysis and physical testing-tensile strength, Fatigue, impact, tear resistance, hardness and adhesion resistances.

4. Structure and properties:

Morphology and order in crystalline polymer configurations of polymer chains, crystal structure of polymers, morphology of crystalline polymers, strain induced morphology, crystallization and melting, crystalline melting temperature T_m , effect of chain flexibility and steric factors, entropy and heat of fusion. The glass transition temperature T_g , relationship between T_m and T_g , effects of molecular weight, diluents, chemical structures, chain topology, branching and cross linking, property requirements and polymer utilization.

5. Properties of commercial polymers:

PE, PVC, Polyamides, Polyesters, Phenolic resins, epoxy resins, silicone polymers, Functional polymers, Fire-retarding polymers and electrically conducting polymers, biomedical polymers: contact lens, dental polymers, artificial hearts and skin materials

References:

1. Text book of polymer sciences, F. W. Billmeyer, Jr., Wiley
2. Polymer Sciences, V.R. Gowariker, N. V. Biswanathan, J. Sreedhar, Wiley-Eastern
3. Contemporary polymer chemistry, H. R. Alcock, F. W. Lambe, Prentice Hall
4. Physics and chemistry of polymers, J. M. G. Cowie, Blackie academic and professional.

Elective

SAC 3009 Medicinal Chemistry

1. Bio-physicochemical properties

Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as K_i , K_d , LD_{50} , EC_{50} , IC_{50} , CC_{50} , ADMET properties

2. Structural properties

Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with bond length, bond angle and dihedral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereochemically pure drug and recemates, Examples such as catecholamines, etc.

3. Drug target understanding

Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.

4. Medicinal Chemistry of Therapeutic Agent

Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drug, Adrenergic Agents, Cholinergic Drug, Diuretics, Cardiovascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents

Steroids, Prostaglandins, Enzyme, Hormone and Vitamins

Biophysico-chemical properties, Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. Classification of vitamins with examples.

5. Concept of rational drug design

Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR. Brief discussion about the rational discovery of anti-influenza compound and anti-HIV compound.

Reference Books:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...
by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale
2. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, W. O. Foye
3. Remington: The Science and Practice of Pharmacy Vol 1, Ed. 19 by Joseph Price Remington, Alfonso R. Gennaro.
4. **Burger's Medicinal Chemistry** by Manfred E. Wolff, Alfred **Burger**
5. **Burger's Medicinal Chemistry and Drug Discovery** by Alfred **Burger**, Donald J. Abraham.
6. The Organic Chemistry of Drug Design and Drug Action by Richard B. Silverman
7. Exploring QSAR: Fundamental and applications in Chemistry and Biology by Carowari Hansch and Albert Leo, ACS, Washington DC-1995.

Elective

SAC 3011 Supramolecular Chemistry

1. Supramolecular Chemistry and X-ray Crystallography

Introductory concept of Supramolecular Chemistry, Methods for the understanding of supramolecular systems such as NMR and X-ray Crystallography, X-ray Crystallography, Single Crystal, Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structure analysis of crystals, Index reflection, Identification of unit cells, Space Group, Structure of simple lattices and X-ray intensities, Structure factor and its relation to intensity and electron density.

1. Supramolecular Chemistry to understand Non-covalent interaction

Supramolecular assembly by Noncovalent interactions, Definition and examples of supramolecular system to understand noncovalent interaction such as weaker noncovalent interactions, hydrogen bonding, metal coordination, hydrophobic interactions, hydrophilic interaction, electrostatic interactions, van der Waals interactions, arene interactions, π ... π interactions, C-H... π interaction, halogen interactions, cation... π interaction, and charge transfer interactions.

2. Supramolecular Chemistry in Crystal engineering

Concept of the crystal packing, Building block of supramolecular chemistry, Self assembly of organic and inorganic system, Molecular network, Construction of the crystalline materials or new solids, Molecular folding, Interlocked molecular-architecture, Host-guest chemistry, Cavitands, Calixarenes, Cyclodextrin complex with fullerene, Metal-organic materials (benzo-15-crown-5 complex with calcium picrate and water), Gelators fibres and adhesives, Dendrimers, Catenanes, Rotaxanes, Nanomaterials, Novel liquid crystals.

3. Supramolecular Chemistry in pharmaceutical development

Concept of polymorphism, Application of polymorphism to alter biophysico-chemical properties such as melting point, density, compressibility, solubility, stability, hardness, dissolution rates, dipole moment and bioavailability. Analytical techniques such as powder XRD, differential scanning calorimetry (DSC), thermal gravimetric analysis (TGA), hot stage microscopy (HSM), Thermogravimetric/*Infrared* analysis (*TG/IR*), TGMS, NIR, Far-IR, Raman Spectroscopy etc. to characterize the polymorphism. Concept of the co-crystal structure, Pharmaceutical cocrystals: co-crystal of an active pharmaceutical ingredient (API) with non-toxic chemicals.

7. Supramolecular Chemistry in Drug Design

Molecular Recognition, Lock and key theory, Drug Receptor Interaction, Receptor ligand co-crystal study, Nanoparticles in the Drug Delivery System.

Books Required:

1. J. -M. Lehn, *Supramolecular Chemistry: Concepts and Perspectives*, VCH, Weinheim, 1995.
2. *The Weak Hydrogen Bond in Structural Chemistry and Biology* by G. R. Desiraju and T. Steiner, Oxford University Press, Oxford, 1999: 528 pages.
3. *Crystal Design. Structure and Function* edited by G. R. Desiraju, *Perspectives in Supramolecular Chemistry*, 7, Wiley, Chichester, 2003: multi-author work with 9 chapters, 408 pages.
4. J. W. Steed and J. L. Atwood, *Supramolecular Chemistry*, John Wiley and Sons, New York,
5. Desiraju, G. R., Ed. *Perspectives in Supramolecular Chemistry*, Vol. 2: *Crystal Engineering and Molecular Recognition* Wiley: Chichester (1995).

SAC 3013 Computational Chemistry and Drug Design

Credits:3(3-0-0)

- Module 1: Introduction about the computational chemistry and molecular modeling, Coordinate systems, Concept of 2D and 3D structure, molecules, Surfaces, Molecular energetic profile, Brief idea about the computational software's for drawing, visualization and simulation of small and large molecules. Basic concept of Chemoinformatics, 3D-Structure file system and Databases.
- Module 2: Brief introduction about Quantum Mechanics & Molecular Mechanics, Molecular Orbital Theory, The Hartree-Fock method, ab-initio calculation, Semi-empirical methods, Huckel theory, Valence bond theories, Force Field, Geometrical Parameters, Non-covalent Parameters: understanding of electrostatic interactions, van der Waals interaction, Hydrogen bonding, hydrophobic interactions,; application of quantum mechanics and molecular mechanics in drug design.
- Module 3: Computer simulation methods: Minimization, Molecular dynamics, Monte Carlo Simulations, Simulated Annealing, Conformational Search and Conformational Analysis, Understanding of iterations, convergence, protocols and algorithm such as steepest descents, conjugate gradient etc.,
- Module 4 Quantitative Structure Activity Relationship (QSAR): Mathematical parameters or descriptors: Lipophilicity, Electronic and Steric factor, Mathematical Models based on physicochemical relations: Hammett equations, Taft Equation and Linear Free Energy Relationship (LFER), Hansch Equations and Hansch analysis, mixed approach, Other QSAR Approaches
- Module 5: Structure-Based Drug Design: Protein Structure preparation, Ligand structure preparation, Homology modeling, Molecular docking, Induced Fit Docking, Scoring
- Module 6 Drug like properties and its *in-silico* prediction: Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as K_i , K_d , LD_{50} , EC_{50} , IC_{50} , CC_{50} , ADMET. Brief introduction about the computational software for the prediction of drug like properties.

Books:

1. Computational Chemistry, Introduction to Theory and Application of Molecular and Quantum Mechanics. By Errol Lewars, Springer
2. Molecular Modelling : Principle and Application, 2nd Ed. By Andrew R. Leach, Addison-Wesley Longman Ltd, (February 2001) ISBN: 0582382106.
3. Guidebook on Molecular Modeling in Drug Design, J. G. Vinter, Mark Gardner (Editor), CRC Press (May 1994) ISBN: 084937772.

Environmental Pollutant Analysis

1. Basic concepts of Pollutant analysis

Environmental Analysis, errors Sampling & preservation, Modern methods of pollution analysis- Spectroscopic, light scattering technique, molecular luminescence, Electroanalytical, radio analytical, separation techniques like adsorption, partition, ion exchange, HPLC, HPTLC, Solvent extraction

2. Air pollution monitoring and control

Sampling and analysis of air pollutants, Units of pollutants, emission standards from industrial sources, control of air pollutants from mobile and stationary emission sources, Various control methods for particulate emission: gravitational settling chambers, cyclone separators, baghouse filters, electrostatic precipitators and wet scrubbers. Control of gaseous emissions, absorption by liquids, adsorption by solids, combustion. Control of Sox, NO_x, CO, Hydrocarbons from mobile and stationary emission sources. Indoor air quality

3. Water quality and control

Municipal and industrial water quality, Drinking water standards-PHED and WHO, Sampling techniques and preservation of samples, Physical examination, chemical characterization and Biological investigation,

Control measures: Primary, secondary and advanced treatments, Coagulation, flocculation, sedimentation,

Industrial water treatment: softening, corrosion and scale prevention

4. Soil pollution

Soil Pollution: Analysis of micro and macro nutrients in soil, Trace element analysis, pesticide analysis

5. Radiation, Noise and Odour: Measurement and control

Radiation hazards: Types of radiation, sources, effects, control and disposal of nuclear waste.

Noise: Sources of Noise, types of noise, noise measurement, mapping, Control measures-Anechoic chambers, Industrial noise abatement measures, Sources of odour, sampling, measurement

6. Solid waste management

Sources, Classification and composition of MSW, Properties of MSW, MSW management, Waste minimization, Life cycle assessment, benefits, waste reduction techniques, Reuse and recycling, Biological MSW treatment, Thermal treatment, Landfill, Integrated waste management, Case studies

7. Environmental modeling

Type of models: Conceptual, Physical, Mathematical and Computational Validation, verification, sensitivity analysis.

Books recommended:

1. Environmental Pollution Control Engineering by C.S. Rao.
2. Practical Environmental Analysis by Miroslav Radojevic and Vladimir N. Bashkin, RSC.
3. Environmental Pollution Analysis by S. M. Khopker, New Age International Corporations.
4. An Introduction to Environmental Science & Engineering by Gilbert M. Masters.
5. Chemical analysis of ecological materials by S. E. Allen.

Elective

SAC -Chemistry of Environmental Pollutants (SAC 3015)

Module-I Principles of Environmental Chemistry

Importance and Scope of environmental chemistry, Basic Properties of chemicals in the environment, States of matter in the environment, Nature of bonds and their influence on physical and chemical properties in the environment.

Module-II Environmental Transformation and Degradation Processes

Abiotic transformation and degradation: oxidation through combustion, Phototransformation, Hydrolysis, Biotransformation and Biodegradation: Microbial transformation, Types of microbial degradation, Kinetics of transformation and degradation.

Module-III Environmental Toxicology

Routes and Mechanisms of toxicant entry, Distribution of toxicants, Phases of Biotransformation, Excretion of toxicants, Classes of poisons based on effects, Measure of toxicity, Factors influencing toxicity, Bioassays, Alternative methods for toxicity assessment Ecotoxicological concepts, risk assessment process, exposure assessment, dose-response relationship

Module IV Petroleum Hydrocarbons and Polyaromatic hydrocarbons

Petroleum Hydrocarbons: Chemical nature of petroleum, various transformation Processes in the environment, Petroleum in aquatic organisms, Polychlorinated biphenyls and dioximes: sources of environmental contaminants, Physicochemical properties, environmental distribution and behaviour, toxicity, Polycyclic aromatic hydrocarbons: Sources, chemical nature, , mechanism of formation, Carcinogenicity and Toxicity, Effect on Human health

Module V Organometallic Compounds, Soaps & Detergents

Soaps and detergents: Surfactants, synthesis, Sorption and Bioaccumulation, Organometallic compounds: Sources, behaviour and nature of organomercury compounds, organotin compounds, organolead compounds and Organoarsenic compounds,

Module VI Synthetic polymers and Pesticides

Synthetic Polymers: Plastics, Elastomers and synthetic fibers, Combustion, Biodegradation, Photodegradation and recycling of synthetic polymers, Pesticides: Chlorinated hydrocarbon pesticides, organophosphate insecticides, carbamates, Pyrethrins and pyrethroids, Phenoxyacetic acid herbicides.

Books Recommended

1. Basic concepts of Environmental Chemistry : . W. Connell
2. Chemistry and Ecotoxicology of Pollution: D. W Connell and G. J Miller
3. Risk Assessment Methods: Approaches for assessing health and Environmental risks: VT Corvello and MW Morkhofer
4. Environmental Chemistry: Stanley E Mannahan

Atmospheric Chemistry and Climate Change (SAC 3019)

Module- I Atmospheric chemistry overview

Chemical composition of the Earth's Atmosphere, Atmospheric Aerosols and Clouds, Physical properties and structure of the troposphere and the stratosphere, Temperature profile, Different types of inversion, Concentration profiles, Atmospheric radiation and photochemistry

Module-II Chemistry of the Troposphere

Sources, Sinks and Transport, Oxidation and Transformation, Air Pollution, Primary and Secondary Pollutants, Tropospheric chemical cycles, Hydroxyl and chlorine radical, chemical cleansing, hydrocarbons in the troposphere

Module-III Chemistry of the Stratosphere

Atmospheric Chemistry of the Stratosphere – ozone cycle, depletion, Influence of trace constituents, Effect of ozone depletion on surface UV radiation, Polar ozone holes, Man's impact on stratosphere

Module-IV Atmospheric Pollution

Chemistry of oxides of Carbon, Nitrogen, Sulphur, Hydrocarbons and Particulate Matter, Photochemical Smog, Acid rain, Volatile organic compounds, Stationary and Mobile emission sources, Pollution Standard Index, Criterion Pollutants, Ambient Air Quality Standards

Module-V Global Atmospheric Change

Atmospheric stability, Adiabatic lapse rate, Radiation inversion, subsidence inversion, Global temperature, Energy balance, Radiative forcing, Carbon cycle and emissions from fossil fuels, Green House effect and Global warming Potential

Module-VI

Global initiatives

Montreal, Kyoto Protocol and Copenhagen summit, Air pollution regulations: Domestic and International, Environmental disasters, Nuclear accidents, Frontier Areas in Atmospheric Chemistry

Books Recommended:

1. **Chemistry of Atmospheres: Richard P. Wayne**
2. **Introduction to Environmental Engineering: G.M. Masters**
3. **Environmental Chemistry: S.E Mannahan**
4. **Environmental Pollution Monitoring and Control: S.M. Khopkar**
5. **Atmospheric chemistry Fundamentals and Experimental Techniques: Finlayson- B.J Pitts and J.N. Pitts**

Aquatic Chemistry (SAC 3017)

Module- I Introduction to Hydrosphere

Global water Resources, Hydrological cycle, Physical chemistry of sea water, Physical & chemical properties of water, Unusual properties of water, concentration & units used for aqueous solutions, Biochemical Processes

Module-II Distribution of species in water

Structure and interactions of water molecule, Dissociation of Water, Speciation, Distribution of species in aquatic systems, behaviour of solutes, Dissolution of salts, Oxidation-Reduction, pE/pH diagrams, Measurement of pE Gases in water: Gases that react with water, Gas-Liquid Equilibrium, Effect of ionization of dissolved gases, CO₂ dissolution, Alkalinity and Acidity

Module-III Chemistry of Metals in Aqueous Systems

Speciation of dissolved metals, metal ion buffers, metal oxides and hydroxides, Precipitation and Complexation, Redox reactions, Redox titration and geochemical redox sequence, Adsorption reactions

Module-IV Water Pollution

Water Pollutants, Metals, Pesticides and Pathogens, Nutrients, Eutrophication, Trace elements in water, Chemical speciation, Biochemical Oxygen demand, Effect of oxygen demanding waste in rivers, Aquifers, Hydraulic gradient, Darcy's law, Contaminant transport, Contaminants in ground water.

Municipal and waste water quality, Drinking water standards-PHED and WHO, Sampling techniques and preservation of samples, Physical examination, chemical characterization and Biological investigation, Control measures: Primary, secondary and advanced treatments, Coagulation, flocculation, sedimentation

Module-V Industrial Water Pollution

Industrial water: Specifications for industrial water , troubles in boiler water: scales & Sludge formation ,Priming & foaming ,caustic embrittlement, carry over, boiler corrosion, water treatment: softening, external treatment ,internal treatment ,Desalination of brackish water, reverse osmosis, ion exchange.

Module-VI Water Resource Management:

Water Conservation, Rain Water Harvesting, Water Shed Management, Water Pollution and Control Acts, Water Pollution and Public Health

Books Recommended:

1. **Water Chemistry: Mark M Benjamin**
2. **Environmental Chemistry: Stanley E Mannahan**
3. **Chemistry for Environmental Engineering: C N Sawyer, PL Mc Carthy, GF Parkin**
4. **Water in crisis: A guide to the world's fresh water Resources: Gleick P H**

Environmental Impact Assessment (SAC 3021)

Module-I

Pollution Sources, Classification and their effect on environment air pollution

Air Pollution, Sampling and measurement

Module-II

Waste water sampling and analysis, instrumentation, Detailed procedure,

Module-III

Energy and environmental correlation, case studies on power plants, cement industry, iron and steel, chemical and refinery.

Module-IV

National environmental policy, methodology of environmental impact studies, methods of impact identification, Production and assessment of impacts on the air environment,

Module-V

Prediction and assessment of impacts on surface water, soil and ground water environment,

Module-VI

Socio economic environment, Evaluation alternatives, Public participation in environmental decision making

Books Recommended:

1. Risk Assessment Methods: Approaches for assessing health and Environmental risks: VT Corvello and MW Morkhofer
2. A Handbook of Environmental Chemistry: O. Hutzinger
3. Environmental Pollution Monitoring and Control: S.M. Khopkar

Elective

Electrode

Electrified interface and electrode, thermodynamics and kinetics of electrochemical reaction, Butler-Volmer equation, Tafel plot.

Electrochemical techniques: Cyclic Voltammetry, chronocoulometry, chronoamperometry, pulse and squarewave voltammetry, hydrodynamic voltammetry and bulk electrolysis.

Types of electrode reactions-reversible, irreversible and quasi reversible, Electrode reaction with coupled homogeneous chemical reactions.

Spectroelectrochemistry of selected transition metal complexes.

Books:

1. John O'M. Bockris, A.K.N. Reddy and M.G-Aldeco, Modern Electrochemistry, Fundamentals of electrode. Kluwer academic, 2000.
2. Allen J. Bard and L.R. Faulkner, Electrochemical methods, Wiley, 2001.