# 5 Year Integrated M.Sc. in Physics

**Proposed by**

**Department of Applied Physics**
**Birla Institute of Technology**
**Mesra, Ranchi – 835215, Jharkhand.**

## Course Structure and Syllabus for
## Five-Year Integrated M. Sc. Course in Physics
## Total Credits: 211

**Date: 11th Nov, 2013**

| Course Structure for Five-Year Integrated M.Sc. Course in Physics | | | | | | |
|---|---|---|---|---|---|---|
| **First Semester** | **Subject Code** | | **L** | **T** | **P** | **Credit** |
| | IMP 1001 | Physics I (General Properties of Matter and Waves & Oscillations) | 3 | 1 | 0 | 4 |
| | IMC1001 | Chemistry I | 3 | 0 | 0 | 3 |
| | IMM1001 | Mathematics I (Analytical Geometry and Calculus) | 3 | 1 | 0 | 4 |
| **BR** | CS1302 | Fundamentals of UNIX & C Programming | 1 | 0 | 3 | 3 |
| **BR** | HU1103 | English | 2 | 1 | 0 | 3 |
| | IMP1002 | Physics Laboratory I | 0 | 0 | 3 | 2 |
| | IMC1002 | Chemistry Laboratory I | 0 | 0 | 3 | 2 |
| | GA1006 | Co-curricular Activity | 0 | 0 | 2 | 1 |
| | | | | | | **22** |
| **Second Semester** | | | | | | |
| | IMP 2001 | Physics II (Basic Electromagnetic Theory) | 3 | 0 | 0 | 3 |
| | IMC2001 | Chemistry II | 3 | 1 | 0 | 4 |
| | IMM2001 | Mathematics II (Matrix Algebra & Complex Variables) | 3 | 0 | 0 | 3 |
| **BR** | CS2301 | Fundamentals of Data Structures | 3 | 0 | 0 | 3 |
| **BR** | CH2203 | Environmental Science | 3 | 0 | 0 | 3 |
| | IMP 2002 | Physics Laboratory II | 0 | 0 | 3 | 2 |
| | IMC2002 | Chemistry Laboratory II | 0 | 0 | 3 | 2 |
| | CS2302 | Data structure Laboratory | 0 | 0 | 3 | 2 |
| | GA2006 | Co-curricular Activity | 0 | 0 | 2 | 1 |
| | | | | | | **23** |
| **Third Semester** | | | | | | |
| | IMP 3001 | Physics III (Modern Physics) | 3 | 0 | 0 | 3 |
| | IMC3001 | Chemistry III | 3 | 0 | 0 | 3 |
| | IMM3001 | Mathematics III (Ordinary Differential Equations with Special Functions) | 3 | 1 | 0 | 4 |
| **BR** | CS3101 | Java Programming & Web Technology | 3 | 0 | 0 | 3 |
| **BR** | PS3001 | Biological Science | 3 | 0 | 0 | 3 |
| | IMP 3002 | Physics Laboratory III | 0 | 0 | 3 | 2 |
| | IMC3002 | Chemistry Laboratory III | 0 | 0 | 3 | 2 |
| | CS3102 | Java Programming Laboratory | 0 | 0 | 3 | 2 |
| | GA3006 | Co-curricular Activity | 0 | 0 | 2 | 1 |
| | | | | | | **23** |
| **Fourth Semester** | | | | | | |
| | IMP 4001 | Physics IV (Modern Optics) | 3 | 0 | 0 | 3 |
| | IMC4001 | Chemistry IV | 3 | 0 | 0 | 3 |
| | IMM4001 | Mathematics IV (Integral Transform & Partial Differential Equations) | 3 | 1 | 0 | 4 |
| **BR** | MSH1151 | Value Education, Human Rights and Legislative Procedure | 3 | 0 | 0 | 3 |
| | IMP 4103 | Solid State Physics | 3 | 0 | 0 | 3 |
| | IMP 4002 | Physics Laboratory IV | 0 | 0 | 3 | 2 |
| | IMC4002 | Chemistry Laboratory IV | 0 | 0 | 3 | 2 |
| | GA4006 | Co-curricular Activity | 0 | 0 | 2 | 1 |
| | | | | | | **21** |
| **Fifth Semester** | | | | | | |
| | IMP 5001 | Electronics | 3 | 1 | 0 | 4 |
| | IMP 5003 | Heat & Thermodynamics | 3 | 0 | 0 | 3 |
| | IMP 5005 | Optoelectronics | 3 | 0 | 0 | 3 |
| | IMP 5007 | Introduction to Quantum Mechanics | 3 | 1 | 0 | 4 |
| **BR** | SGI 1001 | Principles of Remote Sensing | 3 | 0 | 0 | 3 |
| **BR** | ME 5006 | Computer Aided Design Laboratory | 0 | 0 | 3 | 2 |
| | IMP5002 | Physics Laboratory V | 0 | 0 | 3 | 2 |
| | | **The code 'BR' refers to breadth paper.** | | | | **21** |

| Course Structure for Five-Year Integrated M. Sc. Course in Physics: Contd. | | | | | | |
|---|---|---|---|---|---|---|
| **Sixth Semester** | | | | | | |
| | IMP 6001 | Materials Science and Nanotechnology | 3 | 1 | 0 | 4 |
| | IMP 6003 | Digital Electronics | 3 | 1 | 0 | 4 |
| | IMP 6005 | Introduction to Plasma Physics | 3 | 0 | 0 | 3 |
| | IMP 6007 | Introduction to Nuclear Physics | 3 | 0 | 0 | 3 |
| **BR** | MSH1143 | Foreign Language (French-I) | 3 | 0 | 0 | 3 |
| **BR** | MSH1145 | Foreign Language (German-I) | 3 | 0 | 0 | 3 |
| | IMP 6002 | Physics Laboratory VI - Materials Science Laboratory | 0 | 0 | 3 | 2 |
| | IMP 6004 | Physics Laboratory VII – Electronics Laboratory | 0 | 0 | 3 | 2 |
| | | **Total:** | | | | **21** |
| **Seventh Semester** | | | | | | |
| | SAP 1001 | Mathematical Methods in Physics | 3 | 0 | 0 | 3 |
| | SAP 1003 | Electrodynamics | 3 | 0 | 0 | 3 |
| | SAP 1005 | Classical Mechanics and Relativity | 3 | 0 | 0 | 3 |
| | SAP 1107 | Quantum Mechanics | 3 | 0 | 0 | 3 |
| | SAP 2007 | Statistical Physics | 3 | 0 | 0 | 3 |
| **BR** | IMP 7002 | Modern Computational Techniques & Programming | 1 | 0 | 3 | 3 |
| | SAP 1004 | Physics Laboratory VIII | 0 | 0 | 3 | 2 |
| | **Total:** | | | | | **20** |
| **Eighth Semester** | | | | | | |
| | SAP 2101 | Electronics and Instrumentation | 3 | 1 | 0 | 4 |
| | SAP 2203 | Quantum Electronics | 3 | 0 | 0 | 3 |
| | SAP 2105 | Atomic, Molecular and Modern Spectroscopy | 3 | 0 | 0 | 3 |
| | SAP 2109 | Condensed Matter Physics | 3 | 0 | 0 | 3 |
| | SAP 3109 | Fibre Optics and Integrated Optics | 3 | 0 | 0 | 3 |
| | SAP 2002 | Physics Laboratory IX - Lasers and Advanced Optics Laboratory | 0 | 0 | 3 | 2 |
| | SAP 2004 | Physics Laboratory X - Electronics and Instrumentation Laboratory | 0 | 0 | 3 | 2 |
| | **Total:** | | | | | **20** |
| **Ninth Semester** | | | | | | |
| | SAP 3201 | Nuclear Physics and Engineering | 3 | 0 | 0 | 3 |
| | SAP 3203 | Plasma Physics | 3 | 1 | 0 | 4 |
| | SAP 3015 | Advanced Experimental Techniques | 3 | 0 | 0 | 3 |
| | SAP 3002 | Physics Laboratory XI - Advanced Materials Science Laboratory | 0 | 0 | 3 | 2 |
| | SAP 3004 | Physics Laboratory XII - Plasma Beams and Applications Laboratory | 0 | 0 | 3 | 2 |
| | **Breadth Paper: of PG level of other Departments*** | | 3 | 0 | 0 | 3 |
| | **Elective – 1: (Any one paper)** | | | | | |
| | SAP 3107 | Nonlinear Optics | 3 | 0 | 0 | 3 |
| | SAP 3011 | Nanostructures and Nanomaterials | 3 | 0 | 0 | 3 |
| | SAP 3013 | Thin Film and Vacuum Technology | 3 | 0 | 0 | 3 |
| | SAP 3019 | Biophysics | 3 | 0 | 0 | 3 |
| | IMP 9011 | Microwave Devices & Systems | 3 | 0 | 0 | 3 |
| | IMP 9013 | Physics of Dielectrics and Ferroelectrics | 3 | 0 | 0 | 3 |
| | IMP 9015 | Nonconventional Energy Resources | 3 | 0 | 0 | 3 |
| | TNT 2003 | Nanophotonics | 3 | 0 | 0 | 3 |
| | **Total credits:** | | | | | **20** |
| **Tenth Semester** | | | | | | |
| | IMP-10001 | Project / Dissertation | | | | **20** |
| **Total credits in 10 semesters:** | | | | | | **211** |

*** Should not have been taken earlier by the student in any other programme**

**IMP 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: [5]**

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. Stokes' 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: [4]**

Simple harmonic motion, Motion of simple and compound pendulum, Damping, Forced vibration and resonance, Wave equation in one dimension, Phase velocity, Group velocity, Dispersion.

**Module VII: [4]**

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

**Textbooks:**


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:**


5. Mechanics, D. S. Mathur.
6. Mechanics, Shukla R.K. and Srivastava A.
7. Physics Course vol. I, Berkeley
8. Textbook of Sound, Wood A. B.
9. Waves and Oscillations, French

**IMC1001 Chemistry-I (3-0-0-3)**

**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 $NH_3$, $H_3O^+$, $SF_4$, $CIF_3$, $ICI_2$ 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. Liquefaction 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 (Markownikoff's 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

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

**Module I: Analytical Geometry (2D & 3D) [6]**

Polar equation of conics. Cones, cylinders and conicoids, Central conicoids, normals and conjugate diameters.

**Module II & III: Differential Calculus [12]**

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.

**Module IV: Integral Calculus [6]**

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.

**Module V: [6]**

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.

**Module VI: Vector Calculus [6]**

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.

**Books:**


1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 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 Vol. 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 1302 Fundamentals of UNIX and C Programming (1-0-3-3)**

**Module I:** **[6]**

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:** **[4]**

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

**Module III:** **[5]**

One-dimensional Arrays and their declaration and Initializations, Two-dimensional Arrays and their initializations, 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:** **[5]**

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:** **[5]**

Defining Structure, Declaring Structure Variable and Accessing Structure Members, Initialization 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:** **[6]**

Understanding Pointers, Accessing the Address of a Variable, Declaration and Initialization 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. **[4]**

**Textbook:**

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

**Reference:**

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

**HU 1103 ENGLISH** **(2-1-0-3)**

**MODULE 1:**

1. Short stories

A) The Castaway – Rabindranath Tagore

B) Mr. Knowall - 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)- Macmillan India Ltd.
2. Modern Masters – An Anthology of English prose; Board 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

**IMP 1002 Physics Laboratory-I** **(0-0-3-2)**

1. Study of time-period variation of a simple pendulum for small and large oscillation angles.
2. Determination of acceleration due to gravity using a bar pendulum
3. Determination of Young's modulus, of material of a thin wire using Vernier apparatus.
4. Determination of Young's modulus of the material of a metal bar by the method of bending of beam.
5. Determination of modulus of rigidity of a thick wire by using Barton's apparatus.
6. To study the standing waves on a stretched string and verify the relation between tension, frequency and number of loops.
7. Determination of surface tension of a liquid by capillary tube method.
8. Determination of viscosity of liquid using Poiseuille's method.
9. Determination of viscosity of a gas (or air) by Rankine's method
10. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of material of a thick wire using Searle's method.
11. Measuring velocity of sound by Lissajous figures method
12. Determination of frequency of ac mains using sonometer.

**IMC 1002 Chemistry Laboratory-I (0-0-3-2)**

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
   Acetanilie 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. Vogels 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

**GA 1006 Co-curricular Activity (0-0-2-1)**

**IMP 2001 Physics II - Basic Electromagnetic Theory (3-0-0-3)**

**Module I: Fields [5]**
Vector and scalar fields, physical and mathematical concepts of gradient, divergence and curl, Gauss's theorem and Stokes' theorem.

**Module II: Electrostatics I [5]**
Coulomb's law, Gauss's law in integral and differential form, electric potential and relation with E, electrostatic energy density,

**Module III: Electrostatics II [5]**
Dielectrics, Relation between E, D and P vectors, dielectric susceptibility, boundary conditions on E and D.

**Module IV: Magnetism I [5]**
Motion of charged particles in electric and magnetic fields, Biot-Savart law, Ampere's law in integral and differential form, applications, Hall effect.

**Module V: Magnetism II [7]**
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.

**Module VI: Electromagnetic theory I [4]**
Faraday's law of electromagnetic induction in integral and differential form, Inductance, magnetic energy density, continuity equation for charge, displacement current,

**Module VII: Electromagnetic theory II [4]**
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.

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

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

**IMC 2001 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]**

Comparataive 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 Wilev
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

**IMM 2001 Mathematics II - Matrix Algebra & Complex Variables (3-0-0-3)**

**Module I: Inequalities [3]**

A.M., G.M. Cauchy Schwartz inequality, Weirstrass's inequality, Holder's inequality. Simple Continued Fractions

**Module II: Infinite series [6]**

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.

**Module III: Matrix Algebra [9]**

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.

**Module IV: Theory of equations [6]**

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 Cardano's method, solution of bi-quadratic equations by Ferrari's and Descarte's method.

**Module V & VI: Complex variables [12]**

Introduction to complex variables. Functions of a complex variable. Limit, continuity, differentiability and analyticity of complex functions. Cauchy-Riemann 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.

**Textbooks:**


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 2301 Fundamentals of Data Structures (3-0-0-3)**

**Module I: Algorithms and Analysis of Algorithms [5]**
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: Arrays, Stacks and Queues [5]**
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: Linked List, Linked Stacks and Linked Queues [5]**
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: Trees, Binary Trees, BST, AVL Trees and B Trees [6]**
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: Graphs [5]**
Introduction, definitions and basic techniques, representation of graphs, Graph traversals, Single source shortest-path problems. Minimum cost spanning Trees.

**Module VI: Sorting [5]**
Introduction, Shell Sort, Quick Sort, Heap Sort.

**Module VII: Searching**: **[4]**
Introduction, Binary Search, Transpose Sequential Search, Interpolation Search.

**Textbooks:**

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.

**CH 2203 Environmental Science (3-0-0-3)**

**Module I : Introduction to Environment Pollution [6]**

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: Air Pollution [8]**

Composition, major sources of air pollution, their detrimental effects, stationary emission sources, some control methods, eg. cyclone separators, west scrubbers electrostatic precipitators etc.
Automobile emission control, smog, green house effect, ozone depletion, global warming and acid rains etc.

**Module III: Water Pollution [6]**

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: Industrial Water [5]**

Specification for boiler feed water, internal and external treatment, ion exchange electro dialysis and reverse osmosis.

**Module V: Sewage Treatment [5]**

Composition aerobic & anaerobic treatment, chemical & biological oxygen demand.

**Module VI: [3]**

A brief Introduction to Noise Pollution & Radioactive Pollution

**Module VII: [3]**

Soil pollution and solid waste management

**Books Recommended:**

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

**IMP 2002 Physics Laboratory-II (0-0-3-2)**

1. Measurement of unknown resistance using meter bridge and Carey Foster bridge (using end correction technique)
2. Determination of (a) resistance per unit length of the bridge wire; (b) an unknown resistance using Carey Foster Bridge.
3. Determination of thermal conductivity of a bad conductor using Lee's disc method
4. Determination of mechanical equivalent of heat by electrical method
5. Measurement of voltage and frequency of a sinusoidal waveform using a CRO and to determine unknown frequencies by producing Lissajous figures.
6. To study the frequency response of series and parallel LCR circuit using CRO
7. Determination of emf and internal resistance of a cell using a stretched wire potentiometer.
8. Determination of refractive index of glass using traveling microscope.
9. Determination of refractive index of the material of prism by minimum deviation method.
10. Determination of melting point of solid using platinum resistance thermometer
11. Verification of Lorentz force relation using current balance
12. Determination of magnetic field along the axis of a coil using Stewart and Gee's tangent galvanometer with sliding compass.

**IMC 2002 Chemistry Laboratory-II** **(0-0-3-2)**

1. Volumetric analysis

(a) Determination of acetic acid in commercial vinegar using NaOH

(b) Estimation of calcium content in chalk as calcium oxalate by permangatometry.

(c) Estimation of hardness of water by EDTA.

(d) Estimation of copper using thiosulphate

2. Synthesis and analysis

(a) Preparation of Ni-DMG complex, $[Ni(DMG)_2]$

(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-, BrO3, , I-, SCN-, S2-, SO42-, S2O3, 2-, NO3-, NO2-, PO43-, BO33-, CrO4 2-/ Cr2O7 2-, Fe(CN)6 4-, Fe(CN)6 3-.

Insoluble Materials: Al2O3, Fe2O3, Cr2O3, SnO2, SrSO4, BaSO4, CaF2.

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.

**GA 2006 Co-curricular Activity (0-0-2-1)**

**IMP 3001 Physics III - Modern Physics (3-0-0-3)**

**Module I: Atomic structure [5]**

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.

**Modules II & III: Vector atom Model [8]**

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.

**Module IV: Multi electron Atom [4]**

Pauli's exclusion principle, shell structure, Hund's rule, Atomic ground state and periodic table.

**Module V: Molecular spectra [6]**

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.

**Module VI: Special theory of relativity [6]**

Postulates, Galilean transformations, Lorentz transformations, length contraction, time dilation, velocity addition, mass change and Einstein's mass energy relation.

**Module VII: Introduction to X-ray [6]**

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.

**Textbooks:**

1. Modern Physics, Arthur Beiser, Tata McGraw-Hill Edition (2008)
2. Modern Physics, R. A. Serway, C. J. Moses & C. A. Moyer, Thomson books (2007).

**Reference books:**

1. Introduction to Modern Physics, Richtmeyer, Kennard, Cooper, McGraw-Hill Book Company

**IMC 3001 Chemistry III (3-0-0-3)**

**Module I: Thermodynamics [6]**

Thermodynamic terms, State and path functions and their differentials. Thermodynamic process. Concept of heat and work. First Law of thermodynamics, energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule – Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic condition for reversible process. Introduction to Thermo chemistry, Kirchhoff's equation. Second law of thermodynamics

**Module II: Chemical Equilibrium [6]**

Equilibrium Constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle. Reaction isotherm and reaction isochore, Clausius – Clapeyron equation and applications.

**Module III: Oxidation and Reduction [5]**

Nernst Equation, Electrochemical series, Use of redox potential data – analysis of redox cycle,. Principles involved in the extraction of the elements.

**Module IV: Chemistry of d and f block Elements [6]**

Characteristic properties of d- and f- block elements. Properties of the elements, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry. lanthanide contraction, complex formation

**Module V: Hydroxy and Carbonyl Compounds [7]**

Preparation of monohydric alcohols from carbonyl compounds using Grignard reagents, Methods to distinguish between Primary, secondary and tertiary alcohols (Lucas, Victor Meyer's and oxidation method) Preparation of aldehydes and ketones by Rosenmund's reduction, Oppeanauer oxidation. Reactions of aldehydes and ketones (Reduction using $LiA1H_4$, Clemensen and Wolf-Kishner reduction, reaction with alcohols) Mechanism of Aldol condensation, Cannizzaro's reaction, Reimer-Tiemann reaction, Perkin's reaction, Benzoin condensation.

**Module VI: Organic Compounds of Nitrogen [6]**

Preparation of nitroalkanes and nitroarenes, Separation of primary, secondary and tertiary amines using Hinsberg and Hoffmann method, Structural & basicity relation of amines, Amine salts as phase transfer catalyst, Reduction of nitro compounds, Reductive amination of aldehyde and ketones, Gabriel-phthalimide reaction, Synthetic transformation of aryl diazonium salts, azo coupling.

**Books Recommended:**


1. Chemistry of the Elements by N. N. Greenwood & Earnshaw, Pergamon
2. Metalo-organic Chemistry by A. J. Pearson, Wiley
3. Physical Chemistry by Samuel Glasstone
4. Physical Chemistry by Ira. N. Levine TMH
5. Organic Chemistry by Morrison Boyd
6. Organic Chemistry by Finar
7. Fundamentals of Organic Chemistry Solomons, John Wiley

**IMM 3001 Mathematics III - Ordinary Differential Equations with Special Functions (3-1-0-4)**

**Module I: Differential Equations [6]**

Linear Differential equation of Ist 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.

**Module II: [6]**

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

**Module III: [6]**

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.

**Module IV & V: Special Functions [12]**

Bessel, Legendre and Hypergeometric equations, Confluent Hypergeometric equation, Self adjoint eigen value problems, Green's functions, Second order boundary value problems, Sturm Liouville problems.

**Module VI: Fourier Series [6]**

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

**Textbook:**

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

**Reference Books:**

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

**CS 3101 Java Programming & Web Technology (3-0-0-3)**

**Module I:** **[6]**

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, labeled 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:** **[5]**

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:** **[4]**

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

**Module IV:** **[5]**

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:** **[5]**

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:** **[6]**

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:** **[5]**

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

**Textbook:**


1. Dietel,Dietel - Java How to program , 5th edition; Pearson Education , New Delhi.
2. S. Raj Kamal – Internet 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; New Delhi.
3. Patrick Naghton & H. Schildt - The Complete Reference Java 2, Tata McGraw Hill, New Delhi.

**PS 3001 Biological Science (3-0-0-3)**

**Module I:** **[5]**
Nature and scope of Biology, Life and its origin, Evolution and Maintenance.

**Module II:** **[4]**
The cell as a unity of Life, Structural Organization of Cell, cell division.

**Module III:** **[6]**
Elements of Heredity and variation, Genes and chromosomes, Gene mutation and polyploidy.

**Module IV:** **[8]**
Animal Tissues, Respiratory Gas exchange, Nervous System, Endocrine System, Cardiovascular System.

**Module V:** **[5]**
Biosynthesis of Fats and Terponoids Protein Synthesis, Enzymes.

**Module VI:** **[3]**
Recent developments in Biotechnology.

**Module VII:** **[4]**
Health education: Communicable and Non Communicable diseases, Drug abuse, Drug addiction.

**Books recommended:**

1. Elementary Biology - Trueman's
2. Plant Physiology - Dieter Hess
3. Text book of Botany - A.C. Dutta
4. Text book of Zoology - R.D. Vidyarthi
5. Human Anatomy & Physiology - Marib
6. Text book of Medical Physiology - Guyton & Hall

**IMP 3002 Physics Laboratory – III (0-0-3-2)**

1. Determination of wavelength of sodium light using prism spectrometer
2. Determination of wavelength of sodium light using Newton's rings method.
3. Determination of diameter of a very thin wire placed between two flat glass plates by measuring fringe separation
4. Determination of wavelength of mercury lines by diffraction grating
5. Verification of Brewster's law using sheet polarizers and analyzers
6. Measure the specific rotation of sugar solution using polarimeter
7. Determination of wavelength of light from a sodium lamp using Fresnel's biprism
8. Determination of wavelength of light from a sodium lamp using Michelson's interferometer
9. Determination of slit width using single slit diffraction of laser light
10. Estimation of energy band gap of a semiconductor using a diode
11. Obtaining B-H curve and hysteresis loss for given sample
12. Determination of resolving power of grating spectrometer using an adjustable slit

**IMC 3002 Chemistry Laboratory-III (0-0-3-2)**

1. Mixed melting point determination
   a. Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

2. Decolorisation and Crystallization using Charcoal
   a. Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.
   b. Crystallization and decolorisation of impure naphthalene (100 g of naphthalene mixed with 0.3 g Congo Red using 1 g decolorizing carbone) from ethanol

3. Sublimation (Simple and Vacuum)
   Camphor, Naphtalene, Phthalic Acid and Succinic Acid

4. Qualitative Analysis
   a. Element detection and Functional group determination (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and aniline) in simple organic compounds and mixture analysis.

5. Thin Layer Chromatography: Determination of Rf values and identification of organic compounds.
   a. Separation of green leaf pigments (spinach leaves may be used).
   b. Preparation and separation of 2,4-dinotrophenylhydrazones of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60).
   c. Separation of mixture of dyes using cyclohexane and ethyl acetate (8.5: 1.5)

6. One step organic synthesis:
   a. Rf determination, crystallization, melting point determination.
   b. UV and IR 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.

**GA 3006 Co-curricular Activity (0-0-2-1)**

**IMP 4001 Physics IV - Modern Optics (3-0-0-3)**

**Physical Optics**

**Module I & II: Interference [10]**

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.

**Module III: Diffraction [7]**

Fresnel's diffraction, Zone plate, diffraction due to straight edge. Fraunhoffer diffraction due to single and double slits, plane transmission grating and its resolving power.

**Module IV & V: Polarization [10]**

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.

**Module VI: Lasers [5]**

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.

**Module VII: Holography [3]**

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

**Textbooks:**

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

**Reference books:**

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

**IMC 4001 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.

**IMM 4001 Mathematics IV - Integral Transform & Partial Differential Equations (3-1-0-4)**

**Module I: Laplace Transform [6]**

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.

**Module II: Fourier Transform [6]**

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.

**Module III & IV: Integral Equations [12]**

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.

**Module V&VI: Partial Differential Equations [12]**

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.

**Textbooks:**


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:**


1. Zill, Differential Equations, Thomson Learning, 5th ed., 2004
2. F H Miller, Partial Differential Equations -- J. Wiley & Sons, Inc.
3. F H Miller, Partial Differential Equations -- J. Wiley & Sons, Inc.

**MSH 1151 Value Education, Human Rights and Legislative Procedure (3-0-0-3)**

**Module I:** **[6]**
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:** **[7]**
Indian Constitution: Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive, and Judiciary: Their Composition, Scope and Activities.

**Module V:** **[5]**
The Legislature: Function of Parliament, Constitution of Parliament, Composition of the Council of the States, Composition of the House of People, Speaker.

**Module VI:** **[5]**
Legislative Procedure: Ordinary Bills, Money Bills, Private Member Bills; Drafting Bills; Moving the Bills, Debate, Voting, Approval of the President/Governor.

**Module VII:**
Vigilance: Lokpal and Functionaries; Introduction to RTI **[3]**

**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,

**IMP 4103 Solid State Physics (3-0-0-3)**

**Module I: Crystal structure: [5]**
Bravais space lattices, basis, lattice vectors, crystal systems, primitive cell, unit cell, packing fraction, SC, FCC, BCC, HCP systems, relation between density and lattice constant, Miller indices, lattice planes and directions, relation between interplanar spacing and lattice constants, X-ray diffraction, Bragg's law

**Module II: Crystal bonding: [5]**
Types of bonding in solids, nature of ionic, covalent, metallic, van der Waals, and hydrogen bonding (qualitative), mixed bonding, properties of materials with these bonds, concept of cohesive energy.

**Module III: Electrical properties of solids: [5]**
Free Electron Theory of metals, drift velocity, microscopic form of Ohm's law, conductivity, mobility of charge carriers, Hall effect & Hall coefficient, Band theory (qualitative), resistivity, variation with temperature, thermoelectricity, thermocouples, applications

**Module IV: Semiconductors: [5]**
General properties, band structure, intrinsic and extrinsic semiconductors, Fermi level, carrier concentration, carrier statistics, electrical conductivity, mobility of charge carriers, effect of temperature on carrier concentration, metal semiconductor junction properties.

**Module V: Dielectrics: [5]**
General concepts and properties, applications, dielectric constant, permittivity, losses, dielectric breakdown, measurements, dipole moment, types of polarization, polar molecules, Langevin's theory of orientational polarizability, Clausius–Mossotti equation, Ferroelectric behaviour

**Module VI: Magnetism: [5]**
Classification of magnetic materials, qualitative concepts of diamagnetism and paramagnetism, ferromagnetism, hysteresis, domains, Weiss theory, Curie law, anti-ferromagnetism, ferrimagnetism, ferrites, atomic theory of magnetism, origin of permanent magnetic moments

**Module VII: Superconductivity: [5]**
Historical, general concepts and properties, critical temperature, Meissner effect, critical field, Type-I and Type-II superconductors, introduction to high TC superconductors, applications.

**Textbooks:**
1. Introduction to Solid State Physics: C. Kittel, Wiley Eastern ltd., New Delhi - 1988.
2. Solid state Physics: A. J. Dekker, Macmillan, Ed. 2011.

**Reference books:**
1. Solid state Physics: M.A.Wahab, Narosa
2. Elementary Solid State Physics: M Ali Omar, Pearson

**IMP 4002 Physics Laboratory – IV (0-0-3-2)**

1. Determination of Hall coefficient, carrier type; concentration and mobility of a semiconductor sample
2. Measurement of differential wavelength of the Na doublet using Fabry-Perot interferometer
3. Obtaining the refractive index ratio of a gas and air using Mach-Zehnder interferometer
4. Determination of Planck's constant using LEDs
5. Study of characteristics of a Zener diode
6. Study of characteristics of a thermistor
7. Determination of resistance and temperature coefficient of resistance of copper by using Kelvin's double bridge
8. Determination of solar cell electrical output for different intensities of incident light.
9. Determination of Stefan's constant
10. Determination of Y, k and $\eta$ of a steel using Searle's method
11. Study of stress-strain behavior of rubber
12. Determination of Rydberg's constant using spectrum from a hydrogen source

**IMC 4002 Chemistry Laboratory IV (0-0-3-2)**

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 & $\lambda$ max for $KMn0_4$ 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.

**Recommended books:**

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

**GA 4006 Co-curricular activity (0-0-2-1)**

**IMP 5001 Electronics (3-1-0-4)**

**Module I: Network theorems [4]**

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem

**Module II: Devices [4]**

Types, structure, characteristics and operation of p-n junction diode, Zener diode, LED, BJT, FET

**Module III: Amplifiers [9]**

Transistor configurations, biasing; small signal BJT amplifiers: h-parameters (CE only), RC coupled amplifier, frequency response, amplifier cascade, emitter-follower and Darlington configurations; Power amplifiers: class A, B (Push-pull). Feedback in amplifiers: negative and positive feedback.

**Module IV: Oscillators [3]**

Barkhausen criterion for sustained oscillation; RC phase shift, Hartley, Colpitts and crystal oscillator.

**Module V: Communication principles [6]**

Elementary theory of amplitude modulation, DSB, SSB and VSB; envelope and synchronous detection of AM signals, principle of superheterodyning; FM and PM, and demodulation of FM signals using slope detector and PLL.

**Module VI: Operational amplifiers [4]**

Op-amp, its properties, differential amplifiers, inverting and non-inverting amplifiers, adder, integrator and differentiator.

**Module VII: Power Supplies [5]**

Half and full wave rectifiers, efficiency and ripple factor; filters (C, L, pi), Regulated power supply using Zener diode.

**Recommended books:**


1. Integrated Electronics. Millman & Halkias, Tata-McGraw Hill Edition
2. Engineering Electronics, J. D. Ryder, McGraw Hill Book Company
3. Electronics Fundamentals 7/e, T. L. Floyd, Pearson International Edition

**IMP 5003 Heat and Thermodynamics (3-0-0-3)**

**Module I: [4]**
Concept of heat and temperature, Measurement of temperature, thermometers and thermocouple (SS). Kinetic theory of gases; equation of state of a perfect gas; significance of temperature, derivation of the gas laws, mean free path.

**Module II: [6]**
Maxwell's law for the distribution of velocities and its verification; mean speed, root mean square speed and most probable speed, degrees of freedom, equipartition of energy, application to specific heats; Transport properties: viscosity and thermal conductivity of a gas; Diffusion in gases

**Module III: [5]**
Conduction of heat: conductivity and diffusivity; Fourier equation for the propagation of heat and its steady state solution for rectilinear flow of heat; Measurement of thermal conductivity for good and bad conductors.

**Module IV: [4]**
Basic concepts of thermodynamics: macroscopic and microscopic points of view of thermodynamics, Thermodynamic systems and thermodynamic equilibrium, Quasistatic process;

**Module V: [6]**
Laws of thermodynamics: The first law of thermodynamics, isothermal and adiabatic changes in perfect and real gases. Reversible and irreversible processes; The second law of thermodynamics; Carnot cycle and the Kelvin temperature scale; Clausius theorem; Entropy and its physical interpretation.

**Module VI: [4]**
Thermodynamic functions: Helmholtz free energy, Specific heat, Gibb's free energy and enthalpy functions.

**Module VII: [6]**
Radiation: Concept of radiation, emissive and absorptive power of different bodies, black body radiation, Kirchhoff's law, pressure of radiation, the Stefan-Boltzmann law and its experimental verification. Nernst heat theorem and the third law of thermodynamics.

**Textbooks:**

1. Heat & Thermodynamics: M. W. Zemansky (McGraw-Hill, International Editions)
2. Heat and Thermodynamics, Brij Lal and N. Subrahmanyam (S Chand and Co. Ltd)

**Reference:**

1. A treatise on heat: M. N. Saha, B. N. Srivastava (Indian Press 1958)

**IMP 5005 Optoelectronics (3-0-0-3)**

**Module I: Overview of Optical Fibers [5]**
Introduction to optical fibers, types of fibers, fiber parameters, attenuation, dispersion, fabrication and application.

**Module II: Theory of Optical Waveguides [6]**
Planar, rectangular, Channel and strip loaded waveguides; symmetric and asymmetric waveguide. Modes in waveguide structures, cut off conditions Anisotropic waveguides, guided and radiation modes.

**Module III: Optical Sources [5]**
Light -Emitting Diodes and laser diodes, Fiber lasers. Power launching and coupling techniques. Source of Power coupling. Fiber to Fiber joints and splitting techniques.

**Module IV: Photo Detector [5]**
Photo Detectors, PIN Photodiodes and Avalanche photodiode.

**Module V: Optical Amplifiers [4]**
Semiconductor optical amplifier, mechanisms and rate equations, EDFA, amplification.

**Module VI: Fiber Optics Sensors [5]**
Concept of sensors, transmissive, reflective, micro bending displacement sensor, Temperature sensor, Pressure sensors, Flow sensor, liquid Level sensor, Magnetic and Electric field sensors. Principle of interferometric sensors

**Module VII: Elements of Optical communications [5]**
Couplers, connectors, splices, multiplexers, circulators, splices, isolators, sources and detectors.

**Books:**


1. Optical Electronics; A.K. Ghatak and K. Thayagarajan
2. Optoelectronics: Amon Yariv
3. Fundamental of fiber optics in telecommunication and sensor systems, B.P. Pal, New Age International (P) limited

**IMP 5007 Introduction to Quantum Mechanics (3-1-0-4)**

**Module I:** **[5]**
Inadequacy of classical physics, black body radiation, origin of quantum theory, photoelectric effect, Compton effect, de Broglie's hypothesis, wave-particle duality, Davisson Germer experiment.

**Module II:** **[5]**
Concept of wave function, probability density and normalization. Free particle wave function, Gaussian wave packet, delta-function representation, Propagation of wave packets, concept of phase and group velocity, spread of wave packet.

**Module III:** **[5]**
Heisenberg uncertainty principle, uncertainty product, consequences of uncertainty relation, examples, natural line-width of spectral lines.

**Module IV:** **[4]**
Operators and expectation value. Probability currents and their relation with the flux in beam of particles, Ehrenfest's theorem.

**Module V:** **[6]**
Schrödinger wave equation, stationary states, eigen functions, degeneracy, bound states in infinite and finite square potential wells, penetration through a potential barrier, alpha decay.

**Module VI:** **[5]**
Linear harmonic oscillator, classical and quantum probability densities, eigenvalue and wave functions, Energy eigenfunction in position space. Numerical problems.

**Module VII:** **[5]**
Angular momentum operators, eigenvalues and eigenfunctions, various commutation relations, spin angular momentum, Pauli Exclusion Principle.

**Textbooks:**


1. Introduction to Quantum Mechanics: B. H. Bransden & C. J. Joachain (English Language Book Society/ Longman).
2. Quantum Mechanics: Theory and Applications; S. Lokanathan and A. Ghatak

**SGI 1001 Principles of Remote Sensing (3-0-0-3)**

**Module I: Basic Principles**

- Remote Sensing: History, Development, Definition, Advantages and Limitations, Concept & Principles
- Electromagnetic Radiation (EMR): Spectrum and its properties, wavelength regions and their applications Atmospheric windows, Interaction of EMR with atmosphere & Earth's Surface
- Spectral response pattern
- Spectral, Spatial, Temporal and Radiometric Resolutions

**Module II: Sensors, Scanners and Detectors**

- Photographic System: Cameras, filters & Films
- Remote Sensing Systems: Platform, types of platforms & its characteristics.
- Sensor classification: Active and Passive, Optical-Mechanical Scanners & Push-broom scanners
- Ground Truth Instruments: GTR

**Module III: Remote Sensing Satellites**

- Satellites & their characteristics – Geostationary & Sun Synchronous
- Earth Resource Satellite: Introduction to commonly used multi-spectral remote sensing satellite systems: IRS Series of Satellites, LANDSAT, SPOT, IKONOS, QUICKBIRD, MODIS, RADARSAT, ERS, etc.
- Weather & Communication Satellites: Introduction, NOAA, TERRA, MOS, INSAT, GOES, etc.

**Module IV: Aerial Photography And Photogrammetry**

- Introduction: Fundamentals of Aerial Photography, Aerial photography planning & execution of photographic flights
- Photogrammetry: Basic concepts of scale, measurements of object height and length,
- Stereo Photogrammetry: Stereovision & Stereoscopes, Stereoscopic Parallax & Parallax Equations
- Relief displacement, Vertical exaggeration

**Module V: Digital Photogrammetry**

- Basic Concepts
- Generation of Digital Photogrammetric Images
- Interior Orientation, Exterior Orientation
- Generation of Digital Elevation Models & Ortho-images

**Module VI: Thermal & Microwave Remote Sensing**

- Thermal Infrared: Introduction, Radiation Properties, Kinetic Heat, Temperature, Radiant Energy and Flux, methods of transferring heat
- Thermal properties of terrain: Thermal Capacity, Thermal conductivity, Thermal Inertia, Thermal Infrared Multispectral scanners, Thermal IR Remote sensing examples
- Microwave: Passive & Active Microwave Sensors, Side looking RADAR, Scatterometer

**Module VII: Remote Sensing Applications**

- Brief introduction to Remote Sensing (RS) Applications: Agriculture, Forestry, Land cover/Land use, Water resources & Earth System Science

**Reference Books**


1. Jensen, J.R., (2006) "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi.
2. George Joseph, (2004) "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad.
3. Sabins, F.F. Jr., (2007) Edition. 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.
4. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA

5. Lillesand, Thomas M. and Kiefer, Ralph, W., (2007) "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York
6. Rampal, K.K., (1999) Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi

**ME 5006 Computer Aided Design Laboratory (0-0-3-2)**

**Module I: Introduction of AutoCad [6]**
Starting a New Drawing, setting units, limits command, Blip mode, grid, snap, ortho, coords etc. Point slection methods, Entity/object selection methods.
**Study of entity Drawing commands**: Line, Pline, circle, arc, ellipse, donut, polygon, Text, Dtext, Qtext, Fillet, Chamfer, offset.

**Module II: Study of Utility Comands [4]**
Block, wblock, insert, Minsert, explode, layer, Undo, Redo, OOPS, Save, quit, End, Colour, Line type.

**Module III: Study of Editing Commands [6]**
Erase, move, copy, array, rotate, mirror, break, extend, trim, stretch, change, pedit, scale, divide, chprop. Study display commands: Zoom, pan, Redraw, Regen, vpoint, Vports.

**Module IV: Study of Hatching and Dimensioning Commands [6]**
Hatch, Bhatch, Hatchedit, Boundary command. Linear dimensioning (horizontal, vertical, aligned), angular dimensioning, Diameter dimensioning, Radius dimensioning.

**Module V: Creating Text and Defining Block Attributes [4]**
Creating Text, creating single line text, Drawing special characters, Editing text, substituting Fonts, Finding and Replacing Text. Defining Attributes, Editing Attribute definition, inserting blocks with Attributes.

**Module VI: Isometric Drawing [4]**
Isometric projection, Isometric Axes and planes, Setting the Isometric grid and Snap, Drawing Isometric objects, Dimensioning Isometric objects, Isometric Text.

**Module VII: [4]**
Computer Aided Drafting practices for different configurations of Engineering applications.

**Recommended Books:**

1. Engineering Graphics with AutoCAD 2004/2006 by James D. Bethune, Prentice-Hall of India Private Limited, New Delhi-110 001, 2002.
2. AutoCAD 2004/2006 with Application by Sham Tickoo, Tata McGraw Hill Publishing Company Limited, New Delhi.


**Reference Book:**

1. Machine Drawing with AutoCAD by Goutam Pohit & Gautam Ghosh, Pearson Education Publication.

**IMP 5002 Physics Laboratory – V** **(0-0-3-2)**

1. Verification of Thevenin's theorem
2. Characteristics of passive filter circuits (low, high and band pass)
3. Characteristics of electronic devices FET; SCR; Varistor
4. Determination of ripple factor of half wave rectifier and full wave rectifier
5. Determination of ripple factor of an unregulated power supply with capacitor input filter
6. Study a Zener regulator and a transistorized regulated dc power supply
7. Study of frequency response and phase of a single stage RC coupled BJT amplifier
8. Study of frequency response and phase of a two stage RC coupled BJT amplifier with feedback
9. Study distortion in large signal class-B push-pull amplifier
10. Study of oscillation frequency variation with values of R & C in an RC phase shift oscillator
11. Experiment with astable multivibrator using two transistors
12. Study of Inverting, non-inverting, integrator, differentiator and differential amplifier using op-amp μA741

**IMP 6001 Materials Science and Nanotechnology (3-1-0-4)**

**Module I: Imperfections and strengthening mechanisms in solids [5]**
Introduction to crystallography, types of imperfections, point defects, edge dislocations, screw dislocations, Burger's vector, dislocation density, surface defects, grains, grain boundary.

**Module II: Elastic deformation [5]**
Elastic deformation, Hooke's law, stress - strain behavior of mild steel, atomic view of elasticity, anelasticity, elastic moduli, plastic deformation, slip, slip systems, resolved shear stress, Frenkel's calculation of theoretical shear strength,

**Module III: Plastic deformation [5]**
Plastic deformation of single crystals and polycrystalline materials, strain hardening, annealing, recovery, recrystallization, grain growth, Introduction to fracture, fatigue, creep

**Module IV: Ceramics and Glasses [5]**
Traditional ceramics, general properties, types, applications. Advanced ceramics, properties and applications, Glasses, general properties, types, applications,

**Module V: Polymers and Composites [5]**
Traditional polymers, classification, properties, applications, Advanced polymers, for optical, electrical and electronic applications. General properties, types, applications of composites Fibre reinforced composites, various types of fibres - plastic, glass, carbon, etc, influence of fibre length & orientation

**Module VI: Introduction to nanotechnology [5]**
Basic concepts of nanotechnology, Nanomaterials (Nanoparticles, nanoclusters, quantum dots). Nanoscale, Effect of Nano scale on Material, Properties: Thermal, Mechanical, Electrical, Magnetic and Optical Properties.

**Module VII: Synthesis of nanomaterials [5]**
Introduction to Nanomaterials Fabrication Techniques: Top-Down Process (Ball Milling, Lithography, Sputtering techniques), Bottom-Up Process (Chemical routes).

**Textbooks:**


1. W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 6th Edition, 2003.
2. W. F. Smith, Principles of Materials Science and Engineering, McGraw Hill International, 1986.
3. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, John Wiley & Sons, 2013.


**References:**


1. The Structure and Properties of Materials, Wiley Eastern
   Vol. –I, Moffatt, Pearsall and Wulff
   Vol. –III , Hayden , Moffatt and Wulff
2. Physical Properties of Materials, M. C. Lovell, A. J. Avery, M. W. Vernon, ELBS.

**IMP 6003 Digital Electronics (3-1-0-4)**

**Module I: Fundamentals [5]**
Difference between analog and digital circuits, binary numbers, binary to decimal conversion, AND, OR and NOT gates (realization using diodes and transistor). Boolean algebra, Boolean equations of logic circuits, De Morgan theorem, NOR and NAND gates; Introduction to various logic families.

**Module II: Combinational logic [4]**
Boolean Theorems, minterm, maxterm, sum of products, products of sum, method of realizing a circuit for a given truth table, minimization using Karnaugh map (elementary ideas).

**Module III: Combinational Circuits [5]**
Adders, subtracters, encoders, decoders, multiplexers, demultiplexers.

**Module IV: Sequential circuits [7]**
Flip-flops, RS, JK, Master Slaves, T and D flip-Flops, controlled registers, shift registers, synchronous and asynchronous counters, controlled counters, up/down counters, ring counter.

**Module V: Timing circuits [4]**
Applications of logic gates in timing circuits, op-amp and its applications in timing circuits, Schmitt trigger, 555 timer.

**Module VI: Memories [5]**
ROM, RAM, PROM, EROM, EEPROM, static and dynamic RAM.

**Module VII: Data converters [5]**
D/A and A/D conversion: D/A converter-resistive network, accuracy and resolution. A/D converter (counter type and SAR), accuracy and resolution.

**Recommended books:**


1. Digital Electronics, Malvino & Leach, McGraw-Hill Book Company
2. Digital Design, 4/e, Morris Mano, Pearson
3. Digital Fundamentals 9/e, Thomas L. Floyd, Pearson
4. Digital Computer Electronics, Albert Paul Malvino, McGraw-Hill Book Company
5. Modern Digital Electronics 4/e, R. P. Jain, Tata McGraw-Hill Education

**IMP 6005 Introduction to Plasma Physics (3-0-0-3)**

**Module I: [8]**
Basics of vacuum technology, gas flow at low pressures, conductance, throughput and pumping speed, vacuum pumps, vacuum gauges, vacuum accessories, components and vacuum systems.

**Module II: [5]**
Introduction and brief history of plasma physics, concept of temperature, plasma as the fourth state of matter, types of plasma, plasma parameter, collective behaviour, quasi-neutrality, plasma frequency, plasma sheath, Debye shielding, criteria for existence of plasma.

**Module III: [5]**
Single particle dynamics; charged particle motion in electric field, magnetic field and in combined electric and magnetic field, basics of ExB drift, drift of guiding center, gradient drift, curvature drift and magnetic mirror.

**Module IV: [7]**
Plasma production: breakdown of gases, I-V characteristic of electrical discharge, Paschen curve, Plasma devices and machines; glow discharge, dc and rf sputtering, vacuum arcs, stabilized atmospheric arc plasma.

**Module V: [4]**
Basic plasma diagnostics: electric probes (single and double), optical emission spectroscopy (basic idea).

**Module VI: [2]**
Plasma Applications: Controlled thermo-nuclear fusion, Tokamaks, Space & Astrophysical plasmas.

**Module VII: [4]**
Industrial applications of plasma: MHD energy conversion, solid sate plasma, gas lasers, plasma displays, plasma lighting, isotope separation, plasmas for sterilization, plasma in semiconductor industry, plasma welding, cutting, drilling, etching, spheroidization and waste disposal.

**Reference Books**:


1. Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen, Plenum Press, 1984
2. Fundamentals of plasma physics, J. A. Bittencourt, Springer-Verlag New York Inc., 2004
3. The Fourth state of matter- Introduction to plasma science, S. Eliezer and Y. Eliezer, IoP Publishing Ltd., 2001
4. Elementary plasma physics, L.A. Arzimovich, Blaisdell Publishing Company, 1965
5. Plasmas – The fourth state of Matter, D. A. Frank-Kamenetskii, Macmillan Press, 1972

**IMP 6007 Introduction to Nuclear Physics (3-0-0-3)**

**Module I: Properties of Atomic Nuclei**
Nuclear size and its determination (electron scattering method), nuclear mass and mass spectroscopy (Aston's mass spectrograph), binding energy , mass defect & packing fraction, nuclear force, Yukawa's theory.

**Module II: Radioactivity**
Types of atomic nuclei (isotopes, isotones, isobars), laws of radioactivity decay, half-life of radioactive nuclide, average life of an atom, successive radioactive transformation, radioactive equilibrium, applications, tracers, radioactive dating

**Module III: Nuclear Models**
Fermi gas Model, liquid drop Model, (Weizsacker semi-empirical mass formula, calculations for some nuclei, determination of coefficients, transitions between odd A isobars, transitions between even A isobars, odd-even effects), magic numbers and basic concepts of shell Model

**Module IV: Nuclear Reactions**
Types of nuclear reactions, conservation laws, Q-value equation, exoergic and endoergic reactions, theory of the compound nucleus, reactions induced by protons, deuterons, α-particles, neutrons, fission, etc

**Module V: Nuclear Energy**
Fissionable and fissile materials, Fission reactors, breeding, Fusion processes in stars, conditions for controlled thermonuclear reactions, Lawson criteria

**Module VI: Nuclear Detectors**
Ionization chamber, proportional counter, Geiger-Muller counter, scintillation counter, semiconductor counter,

**Module VII: Accelerators**
Motion of charged particles in electric and magnetic fields, dynamics of relativistic particles, Van de Graaf generator, tandem van de Graaff, Betatron, Cyclotron

**Books Recommended:**

1. Nuclear Physics- B. Cohen
2. Nuclear Physics-D C Tayal
3. Elements of Nuclear Physics-Pandey & Yadav
4. Nuclear Physics- I. Kaplan
5. Physics of Particle Accelerator-Kalus Wille

**MSH 1143 Foreign Language (French-I) (3-0-0-3)**

**Course Outline**

1. ***Developing the following language skills***
   ***LISTENING- To enable the learners to listen and understand the spoken French language which uses the elementary spoken structures.***
   ***SPEAKING- To enable the learners to speak and engage in simple dialogues in French.***
   ***READING SKILLS AND TEXTUAL COMPREHENSION- To enable the learners to read and understand the elementary texts in French.***
   ***WRITING- To enable the learners to write simple sentences and short paragraphs in French.***
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 French culture.***

**Module I:**
Langue Française, Le pronom personnel, Articles définis et indéfinis, Verbes au présent,
Se présenter et présenter quelqu'un (salutations formelles et informelles)

**Module II:**
Nationalités, professions, nombres, les heures, les jours de la semaine, les mois de l'année, Négation, Demander et donner des infos personnelles

**Module III:**
Articles partitifs, expression de la quantité, Les chiffres, Formule de politesse

**Module IV:**
Adjectifs démonstratifs, Adjectifs qualificatifs (mas/fém., pluriel etc.) et possessifs
Utilisation de « est-ce que ? » et « qu'est-ce que c'est ? » quel, quelle etc.

**Module V:**
Parler de goûts et des préférences et leurs degrés, Trois formes d'interrogation, L'impératif

**Module VI:**
Le présent, futur proche, passé récent, Décrire une personne ou un lieu, Ecrire une carte postale, e-mail

**Module VII:**
Le passe composé, le futur, Parler de ses activités quotidiennes, Décrire la ville, des amis, des parents etc.

**Suggested Reading**


1. Jumelage - Niveau-1, Manjiri Khandekar & Roopa Luktuke, Saraswati House Pvt. Ltd. New-Delhi
2. Le Nouveau sans Frontières-1, Philippe Dominique, Jacky Girardet, Michel Verdelhan & Michel Verdelhan, CLE International, Paris
3. Alter Ego-1, Annie Berthet, Catherine Hugot, Véronique M. Kizirian, Béatrix Sampsons & Monique Waendendries, Hachette, Paris
4. Campus- 1, Jacky Girardet & Jacques Pécheur, CLE international, Paris
5. Libre Echange- 1, Janine Courtillon, Geneviève-Dominique de Salins & Christine Guyot-Clément, Didier, Paris
6. 450 Exercices de phonétique, Lucile Charliac, Jean Thierry, Bernard Loreil & Annie Claude, CLE International, Paris
7. Echo - A1, Jacky Girardet & Jacques Pécheur, CLE International, Paris

**MSH 1145 Foreign Language (German-I) (3-0-0-3)**

**Course Outline**

***The objective of the course is to enable the learners to read, write, listen and understand the basic German language. After completing the course, the learner will be able to comprehend simple questions, write brief messages, introduce themselves and others, ask and reply to simple questions in a conversation on day to day topics etc. Further, the learners would also be exposed to the culture of the German speaking countries.***

**Module I:**

Sich begrüssen, sich vorstellen, sich verabschieden und Woher kommen Sie? Ländernamen, Nationalitätsbezeichnung, Das Verb: Präsens – ( sein, heissen), Personalpronomen: ich und Sie, Verb + Adjektiv, Das Nomen: Singular und Plural, Zahlen von 1 – 10. Antworten mit Ja / Nein

**Module II:**

Das Alphabet, buchstabieren, Das Verb: haben, schliessen, machen, Fragepronomen, Zahlen von 1- 100, Personalpronomen du, er und sie und es, Das Demonstrativpronomen „das", Unterschied zwischen Uhr – Stunde, Negativartikel, Der Artikel: bestimmter und unbestimmter Artikel.

**Module III:**

Reisende im Gespräch, Das Verb: Präsens - (fahren, lesen, nehmen usw.), Vorsilbe und Verb (trennbare Verben), Wortstellung von trennbaren Verben, Präpositionen, Tage – Monate.
Erklärung von drei **sie/Sie,** Der Akkusativ, „es gibt/gibt es"**.**

**Module IV:**

Ein Freunde besucht, über Familie sprechen, Das Nomen: Dativergänzung, Der Dativ und der Akkusativ, Das Fragepronomen: Wem?, Possessiv-Pronomen, Präpositionen mit dem Dativ und mit dem Akkusativ, Wortstellung, Das Zeitadverb.

**Module V:**

Rat geben, Geburtstag feiern, Telefongespräch, Die Uhrzeiten, Modalverben - (wollen, müssen, können), Wortstellung bei Modalverben, Das Personalpronomen bei Akkusativ- und Dativergänzungen und deren Wortstellung.

**Module VI:**

Die Wohnung beschreiben, Ein Zimmer vermieten, Richtungsangaben, Das Demonstrativpronomen: dies, wohen? – wo? – wohin? Präpostionen mit dem Akkusativ oder Dativ, Zahlen von 100 – 1000, Jahreszahlen, Das Verb: dürfen – sollen.

**Module VII:**

Im Supermarkt, Konjugation von möchten, Der Genetiv, Das Präteritum: sein und haben, Reflexivpronomen, Das Perfekt.

**Suggested Readings**


1. Deutschsprachlehre für Ausländer, Heinz Griesbach, Dora Schulz, Max Hueber Verlag.
2. Lagune: Kursbuch: Deutsch als Fremdsprache - A1-I + II, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, Hueber Verlag.
3. Tangram Aktuell – A1-I + II, Roza Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Verlag.

**IMP 6002 Physics Laboratory – VI Materials Science Laboratory (0-0-3-2)**

1. Determination of resistivity and temperature coefficient of resistance of a metal using linear four point probe technique
2. Study the dependence of magnetoresistance on the applied magnetic field for a given sample
3. Determination of coefficient of thermal conductivity of a metal
4. Determination of Curie temperature of given samples
5. Determination of dielectric constant of a material by using De Sauty's bridge
6. Study of emissivity of different surfaces of a hot body
7. Determination of coefficient of linear expansion by wedge air film method.
8. Determination of elastic constants of glass by Cornu's interference method.
9. Mass susceptibility of paramagnetic substance by Quinkes's method
10. To determine the coefficient of viscosity of a liquid by rotating viscometer
11. Calibrate a given thermocouple & determine the melting point of Sn-Pb (60:40) alloy
12. Young's modulus of a metal rod using Searle's optical interference Newton's ring
13. Determination of compound formation, Miller indices & grain size from XRD using PCPDF.
14. Phase identification of given steel samples using Optical Microscope
15. To understand the principle and working of Scanning Electron Microscope & to find out the grain size of a given sample

**IMP 6004 Physics Laboratory – VII Electronics Laboratory (0-0-3-2)**

1. Biasing transistor as switch and study its characteristics
2. Study of transfer characteristics of
    a. TTL / CMOS NAND gate
    b. Schmitt trigger
3. Logic gates truth table verification
    a. AND, OR and NOT gate
    b. NAND and NOR gate
    c. Ex-OR gate
4. Experimental verification of
    a. Full Adder
    b. Multiplexer / Demultiplexer
5. Verification of state tables of
    a. RS flip-flop / JK flip-flop
    b. T flip-flop / D flip-flops
6. Verification of digital to analog conversion using DAC0808
7. Verification of analog to digital conversion using ADC0808

**Semester- VII**

**SAP 1001 Mathematical Methods in Physics (3-0-0-3)**

**Module I: Matrix Algebra** [**4]**
Definition, Algebra of matrices, Special matrices, Eigen-values and Eigen-vectors, LU-Decomposition, Solution of Linear system by LU-Decomposition.

**Module II: Complex variables** **[5]**
Analytic functions, Cauchy-Riemann conditions, Cauchy's Integral theorem and Integral formula, Laurent expansion, Singularities, Evaluation of residues, Residue theorem.

**Module III: Second order differential equations** **[4]**
Partial differential equations of theoretical physics, separation of variables – ordinary differential equations, singular points, series solutions – Frobenius' method,

**Modules IV & V: Special Functions** **[12]**
Gamma and Beta functions, Relation between Gamma and Beta functions, Duplication formula, Error function, Bessel's Functions of different kinds, Integral representations of Bessel's Functions, Orthogonality of Bessel's Functions, Modified Bessel's Functions, Legendre Polynomials, Recurrence relations, Rodrigue's formula, Orthogonality of Legendre Polynomials, Associated Legendre Function, Hypergeometric Functions and its integral representation.

**Module VI: Fourier Series** **[4]**
General Properties, Advantage and uses of Fourier series, Applications of Fourier series.

**Module VII: Integral Transform** **[6]**
Laplace Transform, Inversion, Convolution Theorem, Applications of Laplace Transform; Fourier Transform, Inversion, Fourier Sine and Cosine transform, Convolution Theorem, Fourier transforms of derivatives. Applications of Fourier Transform.

**Textbooks:**


1. Hans J. Weber George B. Arfken, Mathematical Methods for Physicists, (2005), Academic Press.
2. L. A. Pipes, Applied Mathematics for Engineering and Physics (1958) McGraw-Hill.


**References:**


1. Charlie Harper, Introduction to Mathematical Physics (2003), Prentice-Hall India.
2. Erwin Kreyszig, Advanced Engineering Mathematics (1999), Wiley.
3. N. P. Bali, A. Saxena and N.C. S. W. Iyengar, A Text Book of Engineering Mathematics (1996), Laxmi Publications (P) Ltd.

**SAP 1003 Electrodynamics (3-0-0-3)**

**Modules I & II: Electrostatics [10]**

The concept of a scalar potential. Poisson's and Laplace's equations for scalar potential. Green's theorem, Electrostatic field energy density. Solutions of Laplace's equation in rectangular, spherical and cylindrical coordinates using the method of separation of variables. Multipole expansion of potential due to a localized charge distribution. Dipole and quadrupole fields. Interaction energy of dipole and quadrupole in an external field. Electrostatics in matter; Polarization and electric displacement vector. Electric field at the boundary of an interface. Clausius - Mossotti equation.

**Modules III & IV: Magnetostatics, Time Varying Fields and Maxwell's Equations [10]**

Foundations of Magnetostatiscs, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Maxwell's displacement current. Maxwell's equations. Vector and scalar potential. Lorentz and Coulomb gauge. Conservation of energy and momentum of a system of charged particles and electromagnetic fields. Field energy and field momentum.

**Modules V, VI & II: Solutions of Maxwell's Equations and Radiation [15]**

Plane waves in dielectric media. Polarization, reflection and refraction at a plane interface between dielectrics, Fresnel's equations. Phase velocity and group velocity, spreading of a pulse propagating in a dispersive medium, propagation in a conductor, skin depth. Waveguides and cavity resonator. Radiation due to localized oscillatory source, near and far zones, radiated power due to an electric dipole, magnetic pole, example of a centre - fed linear antenna as an electric dipole radiator. Retarded Green's function. Lienard-Wiechert potentials and fields for a point charge. Larmor's formula for power radiated by a slowly moving accelerated charge. Thomson scattering, Rayleigh scattering and application to nanoparticles.

**Textbook:**

1. Classical Electrodynamics, J. D. Jackson

**References:**


1. Introduction to Electromagnetic Fields and Waves, D. R. Corson and P. Lorrain
2. Introduction to electromagnetics, D. J. Griffiths
3. Electromagnetic Theory, J. A. Stratton, McGraw Hill

**SAP 1005 Classical Mechanics and Relativity (3-0-0-3)**

**Modules I: Constrained Motion [3]**
Constraints, Classification of Constraints, Principal of Virtual Work, D'Alembert's principal and its applications

**Modules II: Lagrangian formulation [6]**
Generalized coordinates, Langrange's equations of motion, properties of kinetic energy function, theorem on total energy, generalized momenta, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation, Concept of symmetry, invariance under Galilean transformation, velocity dependent potential.

**Modules III: Hamilton's formulation [4]**
Hamilton's function and Hamilton's equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian of relativistic particles and light rays.

**Modules IV(a): Canonical Transformations [4]**
Generating function, Conditions for canonical transformation and problem.

**Modules IV(b): Poisson Brackets [3]**
Definition, Identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity, (statement only), invariance of PB under canonical transformation.

**Modules V: Rotational Motion [5]**
Rotating frames of reference, inertial forces in rotating frames, Larmor precession electromagnetic analogy of inertial forces, effects of Coriolis force, Foucault's pendulum.

**Modules VI: Central Force [5]**
Two body central force problem, stability of orbits, condition for closure, integrable power laws, Kepler's problems, orbits of artificial satellites, Virial theorem.

**Modules VII: Relativity [5]**
Special theory of relativity, Lorentz's transformation, covariant four–dimensional formulations, force and energy equations in relativistic mechanics

**Textbook:**

1. Classical Mechanics by H. Goldstein, Pearson Education Asia.

**References:**


1. Classical Dynamics of Particles and Systems by Marion and Thomtron, Third Edition, Horoloma Book Jovanovich College Publisher.
2. Classical Mechanics by P. V. Panat, Narosa Publishing Home,, New Delhi.
3. Classical Mechanics by N. C. Rana and P. S. Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
4. Introduction to Classical Mechanics by R. G. Takwale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

**SAP 1107 Quantum Mechanics (3-0-0-3)**

**Modules I & II: Introduction to quantum mechanics [8]**

Schrödinger wave equation, interpretation of wavefunction, probability current density. Solutions of one dimensional square well and potential barrier. Linear harmonic oscillator, Heisenberg and quantum mechanical treatments. Spherically symmetric potential in three dimensions, hydrogen atom.

**Modules III: Angular momentum, spin and identical particles [7]**

Angular momentum, various commutation relations, eigenvalues and eigenfunctions of the angular momentum. Electron spin, Stern-Gerlach experiment, spin operators, Pauli's spin matrices, spinors, the principle of in distinguishability of identical particles, Pauli's exclusion principle.

**Modules IV: Scattering theory and WKB approximation method [6]**

Scattering cross sections and coefficients, scattering by spherically symmetric potentials, scattering by a coulomb field. Born approximations, WKB approximations, boundary conditions in the quasi classical case.

**Modules V & VI: Perturbation theory [8]**

Perturbation independent of time, first and second order, the effect of the electric field on the energy levels of an atom (Stark effect), perturbations depending on time, first order transitions, constant perturbation, Fermi's golden rule, interaction of an atom with electromagnetic radiation, the Einstein's A & B coefficients.

**Modules VII: Relativistic wave equations [6]**

Klein-Gordon equation for a free particle and particle under the influence of an electromagnetic potential, Dirac's relativistic Hamiltonian, Dirac's relativistic wave equation, significance of negative energy states.

**Textbook**

1. Quantum theory by L.I.Schiff. (Tata McGraw, New Delhi)

**References:**


1. Quantum Mechanics by L. D. Landau and E. M.Lifshitz (Pergamon, Berlin)
2. Introduction to Quantum Mechanics; D. J. Griffith
3. Quantum Mechanics by A. K. Ghatak and S. Lokanathan.
4. A Modern Approach to Quantum Mechanics by J.S. Townsend, Viva Books, 2010
5. Quantum Mechanics, B.C. Reed, Viva Books, 2010

**SAP 2007 Statistical Physics (3-0-0-3)**

**Modules I & II: Formalism of Equilibrium Statistical Mechanics [8]**

Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles: microcanonical, canonical, grand canonical, and isobaric, connection to thermodynamics, fluctuations, applications of various ensembles, equation of state for a non-ideal gas, Van der Waals' equation of state, Meyer cluster expansion, virial coefficients.

**Modules III & IV: Quantum Statistics [8]**

Formalism of Fermi-Dirac and Bose-Einstein statistics. Applications of the formalism to:

(a) Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation, Bose- Einstein condensation, degeneracy, BEC in a harmonic potential.

(b) Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat, white dwarf stars.

**Module V: Phase Transitions and Critical Phenomena [8]**

Thermodynamics of phase transitions, metastable states, Van der Waals' equation of state, coexistence of phases, Landau theory, critical phenomena at second-order phase transitions, spatial and temporal fluctuations, scaling hypothesis, critical exponents, universality classes.

**Module VI: Ising Model [8]**

Ising Model, mean-field theory, exact solution in one dimension, renormalization in one dimension.

**Module VII: Nonequilibrium Systems [8]**

Systems out of equilibrium, kinetic theory of a gas, approach to equilibrium and the H-theorem, Boltzmann equation and its application to transport problems, master equation and irreversibility, simple examples, ergodic theorem. Brownian motion, Langevin equation, fluctuation-dissipation theorem, Einstein relation, Fokker-Planck equation.

**Textbook:**

1. Statistical Physics, Landau and Lifshitz, Pergamon Press

**References:**

1. Statistical Physics, R. K. Patharia, Pergamon Press
2. Statistical Physics, Kerson Huang, John Wiley and Sons
3. Statistical Physics, S. K. Ma, World Scientific Publishing, Singapore

**IMP 7002 Modern Computational Techniques & Programming (1-0-3-3)**

**Theory & Lab work using Matlab and Maple software for solving problems of following topics:**

**Module I: Approximation Methods and Errors [4]**
Accuracy and precision, Truncation and round-off errors.

**Module II: Roots of Equations [4]**
Bracketing Methods (false position, bisection), Iteration Methods (Newton-Raphson and secant).

**Module III: Systems of linear algebraic equations [4]**
Gauss elimination, matrix inversion and LU decomposition methods.

**Module IV: Curve fitting and Interpolation [6]**
Least squares regression, Linear, multiple linear and nonlinear regressions, Cubic spline. Newton's divided difference and Lagrange interpolating polynomials.

**Module V: Numerical differentiation and integration [5]**
Divided difference method for differentiation, Newton-Cotes formula, Trapezoidal and Simpson's rules, Romberg and Gauss quadrature methods.

**Module VI: Ordinary differential equations [5]**
Euler's method and its modifications, Runge-Kutta methods, Boundary value and Eigen value problems.

**Module VII: Partial differential equations [7]**
Finite difference equations, Elliptic equations, Laplace's equation and solutions, Parabolic equations, Solution of the heat conduction equation. Finite element method: General approach, Application to 1-dimensional and 2-dimensional problems.

**References:**


1. Numerical Mathematical Analysis, J.B. Scarborough, John Hopkins (1966).
2. Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India (1983)
3. Numerical Methods for Engineering, S.C. Chopra and R.C. Canale, McGraw-Hill (1989).
4. Numerical Methods for Scientists and Engineers, Prentice Hall of India (1988).
5. Electromagnetics and Calculation of Fields, Nathan P-Ida and J.P.A. Bastos, Springer-Verlag (1992).

**SAP 1004 Physics Laboratory – VIII (0-0-3-2)**

1. Determination of thin film thickness using Tolansky interferometric technique and estimate the flatness of a glass plate
2. Determination of elastic constants of a given material using Hyperbolic & Elliptic fringes
    a. Cornu's method - Young's modulus by elliptical fringes.
    b. Cornu's method - Young's modulus by hyperbolic fringes.
3. Determination of dielectric constant of a given insulating material
4. Hydrogen spectrum - Rydberg's constant.
5. Determination of Wavelength and dλ (between D1 & D2) of sodium vapor light using Michelson Interferometer
6. Determination of pump down time and pumping speed of a rotary vane pump
7. Determination of pumping speed of an oil diffusion pump
8. Estimation of leak rate of a vacuum system
9. Determination of conductance of vacuum lines
10. Calibration of Pirani gauge with the aid of McLeod gauge
11. Determination of Lande-g factor of a paramagnetic sample using electron spin resonance

**Semester- VIII**

**SAP 2101 Electronics and Instrumentation (3-1-0-4)**

**Module I: Electronic Devices [4]**
Varactor diode, photo-diode, Schottky diode, solar cell, Principle of Operation and I-V Characteristics of FET, MOSFET.

**Module II: Integrated Analog Electronics [7]**
Basics of operational amplifiers, voltage gain, input and output impedance of inverting amplifier, non-inverting amplifier; phase inverter, scale changer, integrator, differentiator. voltage multiplier, limiter, clipper, clamper and peak-to-peak detector, difference amplifier, instrumentation amplifier, active filters (low-pass, high-pass, band-pass, band-reject/ notch), RC phase shift and Wein bridge oscillators.

**Module III: Advanced applications of op-amps [7]**
Comparators, schmitt trigger, multivibrators, AMV and MMV using 555 timer, waveform generation, power supply circuits, analog computation using op-amps. D/A converters, binary weighted, ladder type, A/D converters, simultaneous, counter type, successive approximation type, dual slope converter.

**Module IV: Digital Electronics [5]**
Introduction to various logic families; Combinational Circuits, adders, subtracters, multiplexers, demultiplexers, encoders, decoders, Sequential circuits, flip-flops, RS, JK, Master Slaves, T and D Flip-Flops, controlled registers, shift registers, synchronous and asynchronous counters, controlled counters, up/down counters, ring counter Memories ROM, PROM, RAM

**Module V: Introduction of measurements and measurement systems [2]**
Measurement basics: range, resolution, linearity, hysteresis, reproducibility and drift, calibration, accuracy and precision. Errors and noise in measurements, basic noise reduction techniques.

**Module VI: Electronic Instruments [7]**
Classification and principles of operation analog electronic voltmeter, DC voltmeter, advantages of digital over analog processing. Digital voltmeter and frequency meter, Kelvin Double Bridge, Maxwell's Bridge; Signal conditioning.

**Module VII: Transducers [4]**
Definition, classification, principle of analog transducer: resistive (strain gauge, thermistor and RTD), capacitive, piezoelectric, thermocouple and LVDT, Actuators: pneumatic cylinder, relay, solenoid.

**Textbooks:**

1. Electronic Devices: Solid State Electronic Devices – B. G. Streetman, PHI, Physics of Semiconductor Devices – S. M. Sze.
2. Electronics Circuits & Systems: Integrated Electronics - Millman & Halkias, McGraw Hill,
3. Operational Amplifiers and Linear Integrated Circuits - R. F. Coughlin, F. F. Driscoll, PHI.,
4. Operational Amplifiers and Linear Integrated Circuits - R. A. Gayakwad, PHI.
5. Digital Electronics: Digital Electronics – Malvino and Leach, TMH.
6. Instrumentation: Electrical and Electronic Measurements and Instrumentation - A. K. Sawhney,
7. Electronic Instrumentation - H. S. Kalsi, Modern Electronic Instrumentation & Measurement Techniques - Helfrick & Cooper


**References:**

1. Electronic Devices and Circuits – T.F. Bogart Jr., J.S.Beasley and G.Rico, Pearson Education, 6th edition,2004.
2. Electronics Fundamentals and Applications, J. D. Ryder, Prentice Hall of India , New Delhi , 1987.
3. Electrical and Electronic Measurements and Instrumentation, Sawhney, Dhanpatrai and Sons, New Delhi, 1982.

**SAP 2203 Quantum Electronics (3-0-0-3)**

**Module I: Beam Optics [5]**
Paraxial theory, Gaussian beam transmission through optical components, Hermite –Gaussian beams, Laguerre-Gaussian and Bessel beams.

**Module II: Optical Resonator (cavity) [5]**
Theory of resonator, ABCD matrix, Stable and unstable resonator, Longitudinal and transverse mode of the cavity.

**Module III: Electro-optics and magneto-optics [5]**
Light propagation in anisotropic media. Theory of electro-optic, magneto-optic and acousto-optic effects and devices.

**Module IV: Laser principle and properties [5]**
Coherence, monochromaticity, divergence .Principle of laser: Absorption and Emission of light, Population inversion, Gain oscillation, Gain saturation, Threshold, Rate – equation, 3 and 4 level systems.

**Module V: Types of lasers [5]**
Continuous wave, Pulsed, Q- switched and Mode locked laser. Different lasers Systems: Design (in brief) and functioning of different lasers - Ruby Laser, Nd: YAG laser He-Ne laser, Co2 laser, Argon ion laser, Excimer laser, Semiconductor laser, Fiber laser.

**Module VI: Laser safety and Applications [5]**
Alignment, Targeting, Tracking, Dimension gauging, Velocity Measurement, Surface quality measurement, Contour mapping, Profile detection, Determination and measurement of atmospheric pollution. Holographic non destructive testing (NDT).

**Module VII: [5]**
Interaction of atom with electromagnetic field, Rabi oscillation, linear absorption and amplification-Beer's Law. Introduction to non-linearity of matter towards its optical properties. Brief introductions to harmonic generation and parametric processes. Nonlinear material (Brief discussion).

**Textbook:**


1. Elements of Photonics: K. Izuka
2. Laser Fundamentals: William T. Silfvast, Cambridge University Press (1998)


**References:**


1. K. Shimoda, Introduction to laser Physics, Springer Verlag, Berlin ( 1984)
2. Laser Electronics: J.T.Verdeyen, 3rd Ed, Prentice Hall ( 1994)
3. Laser Physics, M. Sargent III, M. O. Scully and W. E. Lamb, Jr.

**SAP 2105 Atomic, Molecular and Modern Spectroscopy (3-0-0-3)**

**Module I & II: Atomic Physics**

Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; Spectral terms of two electron atoms, terms for equivalent electrons, L-S and J-J coupling schemes, Singlet-Triplet separation for interaction energy of L-S coupling. Lande Interval rule, Zeeman, Paschen Back & Stark effect; width of spectral lines

**Module III & IV: Molecular Spectroscopy**

Rotational, vibrational and electronic spectra of diatomic molecules; Frank–Condon principle and selection rules, Raman Effect, Rotational Raman spectra. Vibrational Raman spectra. Stokes and anti-Stokes lines and their Intensity difference, Rule of mutual exclusion, Importance of neutral hydrogen atom, Molecular hydrogen, Fluorescence and Phosphorescence

**Module V: NMR Spectroscopy**

Nuclear spin, nuclear resonance, saturation, chemical shift, de shielding, spin-spin interaction, coupling constant J, basic ideas about instrumentation of NMR, applications.

**Module VI: Mass Spectroscopy**

Ion production, fragmentation, ion analysis, ion abundance, mass spectroscopy, instrumentation and application.

**Module VII: Mossbauer Spectroscopy**

Spectral parameters and spectrum display, Isomer shift, quadruple splitting, hyperfine interaction and applications

**Suggested Books:**


1. "Introduction to Atomic Spectra", H.E. White, McGraw-Hill
2. “Atomic Physics”, G. P. Harnwell & W.E. Stephens, McGraw-Hills Book Company, Inc.
3. “Fundamentals of Molecular Spectroscopy” C. N. Banwell & E. M. McCash, Tata McGraw-Hill
4. “Modern Spectroscopy”, J. M. Hollas, John Wiley
5. “Preparation of Molecular Physics” A. Beisen, McGraw-Hill.
6. The Feynman Lectures on Physics by R. B. Feynman, R. B. Leighton, M. Sands, Narosa Publishing House

**SAP 2109 Condensed Matter Physics (3-0-0-3)**

**Module I: Crystal Structure [6]**

Revision of concepts, crystal structure, simple crystals, Miller indices, lattice planes, Bragg's law (SS), structure determination, Laue's method, powder crystal method, rotating crystal method, electron diffraction, neutron diffraction, reciprocal lattice, Ewald's construction, symmetry operations

**Module II: Lattice vibrations [6]**

Lattice specific heat, classical theory, experimental results, Einstein's theory (SS), density of states in 1-D and 3-D, Debye theory of specific heat, thermal conductivity of solids, thermal resistance of solids. Vibrations of a one-dimensional chain of (a) similar atoms and (b) two types of atoms, optical and acoustic modes, concept of phonons.

**Module III: Energy band theory [6]**

Classical free electron theory of metals, drift current, conductivity, mobility, Hall effect (SS). Wave mechanical treatment of electron in a box, electrons in a periodic potential, Bloch's theorem, Kronig-Penney Model, Brillouin zones, energy band structure in conductors, semiconductors, insulators, Fermi-Dirac distribution, Fermi energy density of states, Fermi surface, effective mass.

**Module IV: Magnetism [6]**

Classification of magnetic materials, Langevin's theory of paramagnetism, ferromagnetism, hysteresis, ferromagnetic domains, antiferromagnetism, ferrimagnetism, ferrites, Curie's law, magnetic ordering, Weiss theory of paramagnetism, quantum theory of para & ferromagnetism, paramagnetic resonances, ferromagnetic resonance

**Module V: Dielectrics and ferroelectrics [6]**

Different types of polarization and polarizability (SS) Clausius-Mossotti relation, dielectric constant, dielectric breakdown, dielectric losses, ferroelectric, piezoelectric, pyroelectric behavior. Frequency dependence of dielectric properties, temperature dependence, ferroelectric-paraelectric phase transitions.

**Module VI: Superconductivity [6]**

History, general properties, measurements, critical field, temperature, current, Meissner effect, type-I and type-II superconductors (SS). London equation, penetration depth, optical properties, Cooper pair, BCS theory (Qualitative), coherence length, electron-phonon interaction, flux quantization, Josephson junction, high Tc superconductors.

**Module VII: Introduction to special materials: [4]**

Optoelectronic materials
Materials for solar cells
Liquid Crystal

**References**


1. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd., New Delhi - 1988.
2. Solid State Electronics Engineering Materials, S. O. Pillai, Wiley Eastern ltd. New Delhi, 1992.
3. Solid State Physics: Ashcroft & Mermin
4. Solid State Physics: A. J. Dekker, Macmillan, new Ed, 2011

**SAP 3109 Fiber Optics and Integrated Optics (3-0-0-3)**

**Module I: Overview of Optical Fibers [5]**
Structure of optical fibers. Step-index and graded index fibers; light propagation in optical fibers. Single mode, multimode and W-profile fibers. Ray Optics representation, numerical aperture and acceptance angle.

**Module II: Attenuation and Dispersion [5]**
Attenuation in optical fibers - Absorption - Scattering losses - Radiative losses.Dispersion effects, Material dispersion - Combined effect of material and multipath dispersion - RMS pulse widths and frequency response - Model Birefringence

**Module III: Wave Propagation in Step-index Fibers [5]**
Modes in an ideal step-index fiber, Time dispersion - Material Dispersion and Waveguide dispersion in single-mode fibers.

**Module IV: Wave Propagation in Graded-index Fibers [5]**
Modes in graded index fibers. No. of propagating modes. Inter Model and Intra Model dispersion in graded-index Fibers. Mode coupling.

**Module V: Fabrication processes [5]**
Different fiber fabrication methods- chemical vapor deposition method, axial vapor deposition, plasma enhanced modified CVD.

**Module VI: Photonic Crystal Fibers [5]**
guiding principle, index guiding and band gap guiding. Types of fibers, dispersion, birefringence, polarization and nonlinear property. Device application.

**Module VII: Theory of Optical Waveguides [5]**
Planar, rectangular, Channel and strip loaded waveguides; symmetric and asymmetric waveguide. Step-index and graded index waveguides, Electro-optic and acousto-optic waveguide devices. Modulators, Waveguide Couplers and integrated optics devices.

**Textbook:**

1. Introduction to Optical fibers: A.K. Ghatak and K. Thayagarajan
2. Optoelectronics: AmonYariv

**References:**

1. Optical Fiber Communication Systems by Gerd Keiser.
2. Optical Communication Systems by John Gowar.

**SAP 2002 Physics Laboratory – IX Lasers and Advanced Optics Laboratory (0-0-3-2)**

1. Determination of line width of a laser using monochromator
2. Diffraction of light due to a straight edge
3. Thickness of the enamel coating on a wire - by diffraction.
4. Monochromator calibration
5. Production and analysis of linearly, circularly and elliptically polarized light
6. Calibration of Pellin-Broca prism spectrometer
7. Measurement of screw parameters using a laser beam.
8. Using Michelson's interferometer for the determination of thickness of film and its refractive index
9. Measurement of coherence length of laser using Michelson interferometer.
10. Construction and reconstruction of an object using holography.
11. Diffraction of light by straight edge.
12. Mach-Zehnder Interferometer using a He-Ne laser.

**SAP 2004 Physics Laboratory – X Electronics and Instrumentation Laboratory (0-0-3-2)**

1. Design and performance study of two stage CE, RC coupled BJT amplifier with feedback
2. Determination of operational amplifier parameters: open loop gain, input impedance and output impedance, offset voltage and CMRR
3. Design and performance study of regulated dc power supply
4. Design and performance study of inverting, non-inverting and unity gain, differentiator, integrator amplifier using op-amp
5. Design and performance study of a constant current source
6. Design and performance study of a voltage controlled oscillator
7. Design and performance study of Schmidt trigger circuit
8. Design and performance study of astable multivibrator and mono-stable multivibrator
9. Design and performance study of function generator, RC phase shift oscillator, Wien bridge oscillator
10. Design and performance study of active filters (Low pass, high pass, band pass, band reject)
11. Design and performance study of 8-bit ADC using ADC-0808
12. Design and performance study of thermocouple based temperature controller
13. Combinational circuits: Adders, multipliers, magnitude comparators.
14. Sequential circuits: Flip flops, counters, shift registers. (ripple counter with D type flip-flops; J-K flip-flop and its application to counting)
15. Design of resistive bridge with error amplifier

**Semester IX**

**SAP 3201 Nuclear Physics and Engineering (3-0-0-3)**

**Module I: Nuclear Models**
Liquid drop Model, semi-empirical mass formula, transitions between odd A isobars, transitions between even A isobars, odd-even effects & magic numbers, shell Model

**Module II: Two nucleon problem**
Ground state of deuteron, excited state of deuteron, nature of nuclear forces, spin-dependence of nuclear force tensor forces, meson theory of nuclear force

**Module III: Scattering**
Neutron-proton scattering at low energies, cross-section, scattering cross-section, scattering length, proton-proton scattering at low energies,

**Module IV: Interaction of radiation with matter**
Interaction of charged particles with matter, stopping power of heavy charged particles, energy loss of heavy ions and electrons, Cerenkov radiation, absorption of gamma rays, photoelectric effect, Compton effect and pair production

**Module V: Accelerators & Detectors**
Electron source, ion source, linear accelerator, synchrotron, introduction to advance accelerator (LHC) Ionization chamber, scintillation counter, semiconductor counter, Cerenkov detectors

**Module VI: Elementary particles**
Classification of elementary particles, particles and anti particles, fundamental interactions (response of particles to strong, electromagnetic and weak interactions), elementary particles quantum numbers, conservation laws and symmetry, the CPT theorem

**Books Recommended:**


1. Nuclear Theory- Roy and Nigam
2. Nuclear Physics-D C Tayal
3. Nuclear Physics : D. Halliday
4. Nuclear Physics: I. Kaplan
5. Physics of Particle Accelerators:-Kalus Wille
6. Elementary Particles: I S Hughes

**SAP 3203 Plasma Physics (3-1-0-4)**

**Module I: Introduction to Plasma** [6]

The fourth state of matter, collective behaviour, charge neutrality, space and time scales, Concept of plasma temperature, Debye length, plasma frequency, plasma parameters and criteria for plasma state. Debye Shielding, Plasma sheath, Plasmas in nature and laboratory

**Module II: Basic Processes in plasmas [8]**

Collisions in plasmas, Ionization and the Saha equation, LTE and equilibrium Models, Recombination, Concepts of diffusion, mobility and electrical conductivity, Ambipolar diffusion, Effect of magnetic field on the mobility, diffusion of plasma in presence of magnetic field.

**Module III: Plasma Theory [8]**

Motion of charged particles in electric and magnetic fields, Concepts of elementary kinetic theory of plasmas, Boltzmann and Vlasov equation, Fluid theory of plasma, single & multi fluid approximations, generalized Ohm's law, MHD equations

**Module IV: Plasma Oscillations and waves [4]**

Langmuir oscillations, ion waves, electromagnetic waves along and perpendicular to $B_o$, Alfven waves.

**Module V: Plasma production [6]**

Electrical discharges, Electrical Breakdown in gases, glow discharge, self-sustained discharges, Paschen curve, high frequency electrical discharge in gases, electrode less discharge, Capacitively and inductively coupled plasmas, Electrical arcs.

**Module VI: Plasma diagnostics [4]**

Langmuir probe, Spectroscopic diagnostics.

**Module VII: Plasma Applications [4]**

Controlled thermonuclear fusion, tokamak, MHD generator, plasma display, industrial applications of plasmas, hazardous waste disposal.

**Textbooks:**


1. Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen , Springer; 2nd ed. 1984. latest edition. 2006.
2. Fundamentals of plasma physics, J. A. Bittencourt, 3rd Edition Springer-Verlag New York Inc., 2004
3. The Physics of Plasmas, T. J. M. Boyd and J. J. Sanderson, Cambridge University Press, 2003
4. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
5. Reactions under Plasma conditions Vol. I and II, Venugopalan

**SAP 3015 Advanced Experimental Techniques (3-0-0-3)**

**Module I: X-ray Diffraction Methods [6]**

Classification of crystal system, Bragg's law and Laue conditions, Powder methods, crystal size analysis, Rietveld method of structural analysis, X-ray fluorescence spectroscopy, applications of emission spectra for compounds and alloys, Applications of absorption spectra for solid solutions and transitional metal compounds, Neutron spectroscopy. X-Ray Reflectivity

**Module II: Spectroscopy [5]**

Atomic absorption spectrophotometer and its application to environmental analysis, UV-visible spectroscopy and its application, IR-spectroscopy and its application, AES, XPS, Introduction to RBS, SIMS, and its applications. Raman Spectroscopy (UV and Vis)

**Module III: NMR, EPR spectroscopy [5]**

Principles of magnetic resonance, Instrumentation and specimen preparation techniques, chemical shift, spectral analysis, basic principles of ESR. Some applications to simple solids and liquids. An Introduction to Mossbauer spectroscopy.

**Module IV: Microscopy & Optical Microscopy [4]**

Optical microscopy, metallurgical microscope, TEM, SEM and AFM, specimen preparation, instrumentation and applications, Electron Energy Loss Spectroscopy, Nano indenter and NanoTribometer

**Module V: Thermochemical analysis [3]**

Thermoanalytical techniques, Instrumentation and applications of TGA, DTA, DSC.

**Electrochemical Techniques [3]**

Electrochemical Instrumentation, Coulometry, polarography, cyclic voltametry, application to oxidation-reduction reaction, pulse technique and stripping voltametry.

**Module VI: Vacuum Technology & Thin film Deposition Technique [5]**

Application to Vacuum Technology, Types of vacuum pumps, different technique of thin film deposition CVD, PVD, MBE, MOCVD.

**Module VII: Mass spectrophotometic technique, TLC, HPLC, GC-MS etc**. **[4]**

**Textbook:**

1. Mossbauer Effect: An Introduction to Inorganic and Geo Chemist by G. M. Banchroft, McGraw Hill, 1973

**References:**

1. Spectroscopy, Vol. I, II and III, ed. By Straughan and Walker, John Wiley.
2. Analytical Chemistry by G. D. Christian, 6th edition, John Wiley & Sons.
3. Analytical Chemistry by D. Kealey & P. J. Haines, Viva Books Pvt. Ltd.

**SAP 3002: Physics Laboratory – XI Advanced Material Science Laboratory (0-0-3-2)**

1. Melting point of Sn-Pb (60-40) alloy using thermocouple and DMM
2. Stress-strain properties of materials
3. Deflection test of metal beams
4. Mechanical testing of materials using UTM
5. Contact angle measurement for (a) water and glass; (b) mercury and glass
6. Study of frequency dependence of dielectric constant for a given sample
7. To study hysteresis of ferromagnetic material
8. To find out the surface morphology and roughness of a treated and untreated film by using Atomic Force Microscope (AFM) in its semi–contact mode
9. To study the variation of mass with temperature with the help of TGA (Thermogravimetric Analysis) setup
10. To study the morphology of a sample using SEM and to study elemental analysis by EDX method
11. To determine the thermodynamic constants and glass transition temperature of a given polymer sample using Deferential Scanning Calorimeter (DSC)
12. To measure the frequency dependence of dielectric constant of a ferroelectric material ($BaTiO_3$) using an 'Impedance meter'
13. To characterize the given sample (e. g. Benzoic acid) using Fourier Transform Infrared Spectroscopy (FTIR) technique
14. To find the band gap of a wide band gap semiconductor film by measuring its absorbance of light using UV-visible spectrophotometer
15. Characterization of thin films using XRD and grain-size determination using Scherrer's formula
16. Magnetic susceptibility of a sample

**SAP 3004: Physics Laboratory – XII Plasma Beams and Applications Laboratory (0-0-3-2)**

1. Experimentally obtain Paschen curve and verify Paschen's law for different gases
2. Observe AC breakdown voltage for a gas at different frequencies
3. To study the conditions (like, discharge pressure, electrode distance, discharge tube radii, discharge tube length and gas) of occurrence of striations. (Proving Pupps law)
4. Production of plasma and study of its current-voltage characteristics
5. Influence of discharge electrode geometries on the production of plasma and its current-voltage characteristics
6. Measurement of plasma parameters (floating potential, plasma potential, electron temperature and ion density) of a dc glow discharge using single Langmuir probe
7. Measurement of plasma parameters using double electric probe
8. To launch and detect ion-acoustic waves and demonstrate collective behaviour of the plasma

a. determine the phase velocity of ion acoustic waves using time-of-flight analysis of waveforms
b. determine electron temperature from phase velocity
c. plot dispersion relation ω-k by increasing frequency of excited waves and calculating wavenumber k

9. Measurement of electron temperature using spectroscopic method.
10. Identification of species in a plasma using spectroscopic method
11. Study of anodic vacuum arc characteristics and deposition of thin film.
12. Current-voltage characteristics of an anodic vacuum arc with different materials as consumable anode (Cu, Al, Ni)
13. Current-voltage characteristics of a Cascaded Plasma Arc Generator
14. Estimation of plasma torch efficiency using energy balance.

**Electives**

**SAP 3107 Nonlinear Optics (3-0-0-3)**

**Module I: Origin of Nonlinear Optical Phenomena [5]**
Introduction to nonlinear optics, description of nonlinear optical interaction, phenomenological theory of nonlinearity, nonlinear optical susceptibilities, second and third order optical susceptibilities.

**Module II: Second harmonic Generation [5]**
Sum and difference frequency generation, second harmonic generation (SHG), phase matching of SHG, quasi phase matching, electric field induced SHG (ElFISH), optical parametric amplification.

**Module III: Two level atoms [5]**
Nonlinear Optics in two level approximations, Density matrix equation, closed and open two level atoms, steady state response in monochromatic field, Rabi oscillations, dressed atomic state, optical wave mixing in two level systems.

**Module IV: Optical phase conjugation [5]**
Principle, Aberration correction by OPC, Application of OPC in signal processing.

**Module V: Intensity dependent phenomena [5]**
Intensity dependent refractive index, self focusing, self phase modulation and spectral broadening, optical continuum generation by short optical pulse. Self induced transparency. Spatial and temporal solitons, solitons in Kerr media. Pulse compression. Applications.

**Module VI: Bistability [5]**
Optical bistability, Steady state bistability, absorptive bistability, Dispersive bistability, Optical switching.

**Module VII: Ultra fast Phenomena [5]**
Ultra fast pulse generation with and without mode locking, Generation of femto second pulses, Coherent transients, Optical Nutation, Free induction decay, photon echo.

**Textbook:**

1. Nonlinear Optics: Robert Boyd, Academic Press

**References:**

1. Nonlinear Optics in signal processing: W.Easan and A.Miller, Chapman and Hall
2. Physics of Nonlinar Optics: Guang- Sheng -He and Song-Hao Lin, World Scientific
3. Flytzanis and L.Oudar; Nonlinear Optics: Device and Applications, Springer Verlag, (1986)

**SAP 3011 Nanostructures and Nanomaterials (3-0-0-3)**

**Module I: [08]**
Introduction to Nanotechnology & Nanomaterials, Nanoscale, Effect of Nano scale on Material Properties: Thermal, Mechanical, Electrical, Magnetic and Optical Properties.

**Module II: [05]**
New Behaviour: Size confinement, Interfacial Phenomena, Surface to Volume Ratio, Surface Tension, Quantum Mechanics (Importance of Nanomaterials & its effect on Bulk Properties, Nanomaterials.

**Modules III & IV: [10]**
Nanostructured Materials: Properties and Applications of Nanocrystals, Nanoparticles (Emphasis on Surface to Volume Ratio, Surface Tension, Surface Energy), Nanowires, Nanotubes, Oxide Nanostructures, Nanorods, Biomolecules, Nanostructured Polymers, Nanostructured Coatings & Nanocatalist.

**Module V: [04]**
Introduction to Nanomaterials Fabrication Techniques: Top-Down Process, Bottom-Up Process & Self Assembly.

**Module VI: [04]**
Introduction to Nanomaterials Characterization Methods: AFM, Scanning Probe Microscopy, Nanoindentation, Raman Spectroscopy, XPS & FTIR.

**Module VII: [04]**
Applications of Nanomaterials: Structural and Functional Applications, Electronics Applications & Biological Applications.

**Textbook:**

1. C. P. Poole Jr. and F J Ownes, Introduction to Nanotechnology, Wiley (2003).

**Reference:**

1. D. Tomanek and R. J. Enbody, Science and Applications of Nanotubes, Kluwer (2003).
2. Davies, Introduction to semiconductor Devices, Wiley (2002).

**SAP 3013 Thin Film and Vacuum Technology (3-0-0-3)**

**Module I:** **[5]**
Thermodynamics and Thin Film growth

**Module II:** **[5]**
Vacuum Technology: Gas Laws, Kinetic Theory of Gases, Conductance and Throughput, Gas Sources in a Vacuum Chamber, Vacuum Pumps.

**Module III:** **[5]**
Physical Vapor Deposition: Sputtering (Plasma Physics (DC Diode), rf Plasmas, Magnetic Fields in Plasmas, Sputtering Mechanisms), Evaporation.

**Module IV:** **[5]**
Chemical Vapor Deposition: Mechanisms, Materials, Chemistries, Systems.

**Module V:** **[5]**
Etching: Wet Chemical Etching (Mechanisms, Materials and Chemistries), Dry Plasma Etching/Reactive Ion Etching (Mechanisms, Materials and Chemistries).

**Module VI:** **[5]**
FILM Formation and Structure: Capillarity Theory, Atomistic Nucleation processes, Cluster Coalescence, Grain Structure of Films.

**Module VII:** **[5]**
Thin Film Characterization: Structural, Chemical.

**Textbook:**

1. Thin Film Deposition and Patterning: R. K. Waits, American Vacuum Society, 1998.

**References:**

1. The Materials Science of Thin Films: M. Ohring, Academic Press, Boston, 1991
2. Physics of Thin Films: Ludmila Eckertova, 2nd Plenum Press New York, 1986
3. Thin Film Phenomena: Kasturi L. Chopra, (McGraw-Hill, 1969

**SAP 3019 Biophysics (3-0-0-3)**

**Module I: Introduction [5]**
Laws of Physics and Chemistry, introduction to crystallography, Introduction to chromatography, electrophoresis.

**Module II: Physico-Chemical Techniques to study Biomolecules [8]**
Hydration of macromolecules, diffusion of osmosis, sedimentation, ultracentrifuge, rotational discussion, light scattering, small angle X-scattering, Mass spectrometry.

**Module III: Spectroscopy [4]**
UV spectroscopy, circular dichroism, Fluorescence spectroscopy, IR, Raman and Electron spin spectroscopy, NMR spectroscopy.

**Module IV: Molecular Modeling & Macromolecular Structure [4]**
Building the structure of $H_2O_2$, nucleic acid structure, monomers, polymers, double helical structure of DNA, Polymorphism and nanostructure of DNA, structure of RNA, protein structure: amino acids, virus structure

**Module V: Energy Pathways in Biology [5]**
Free energy, couple reactions, group transfer potential, pyridine nucleotides, photosynthesis, energy conversion pathways, membrane transport.

**Module VI: Biomechanics [3]**
Strained muscles, mechanical properties of muscles, cardiovascular system.
**Neurobiophysics [2]**
Nervous system, physics of membrane potentials, sensory mechanisms.

**Module VII: Origin and evolution of life [4]**
Prebiotic earth, theories of origin and evolution of life, laboratory experiments on formation of small molecules.

**Textbooks:**

1. "Cell and Molecular Biology-Concepts and Experiments" by G.Karp, 2nd ed. John Wiley & Sons, Inc. Singapore, 1999.
2. "Principles of Physical Biochemistry" by K.E. van Holde, C. Johnson, and P.S.Ho. Prentice Hall, 1998.

**IMP 9011 Microwave Devices and Systems (3-0-0-3)**

**Module I:** **[7]**
Introduction to rf & microwave, microwave transmission lines, transmission line equations (and solution), standing waves and standing wave ratio, line impedance and admittance, Smith chart, impedance matching, microwave coaxial connectors

**Module II:** **[7]**
Rectangular Waveguides, TEM, TE & TM mode, power transmission and loss, excitation of modes, characteristics

**Module III:** **[7]**
Rectangular cavity resonator, Q-factor of a cavity resonator, waveguide tee, magic tee, waveguide corners, bends, twists, directional couplers (S-matrix), hybrid couplers, circulators, isolators

**Module IV:** **[3]**
Transferred electron device (TED): Gunn effect diode

**Module V:** **[4]**
Resonant cavities klystron, reflex klystron, helix travelling wave tube (TWT)

**Module VI:** **[3]**
Cylindrical and linear magnetron

**Module VII:** **[4]**
Microstrip lines, parallel strip lines, coplanar strip lines, shielded strip lines

**Recommended books:**

1. Electromagnetic waves and Radiating Systems, E. C. Jordan, K. G. Balmain
2. Microwave Devices and Circuits, Samuel Y. Liao, PHI

**IMP 9013 Physics of Dielectrics and Ferroelectrics (3-0-0-3)**

**Module I, II & III: [15]**

Theory of polarization, Matters in an ac field. Polarization, Macroscopic electric field, Depolarization field, Lorentz field, Field of dipoles inside cavity, Dielectric constant and polarizability, Clausius-Mossotti relation, fallacy of Clausius-Mossotti relation, fallacy of defining polarization via charge distribution, Polarization as an Adiabatic flow of current, Berry Phase theory, the quantum of polarization, Spontaneous polarization, Polarization in an applied electric field.

**Module IV, V & VI: [15]**

Ferroelectric crystal, Landau Primer of ferroelectricity; $2^{nd}$ order transition, $1^{st}$ order transition, soft optical phonons, classification of ferroelectric crystal, crystallographic signature of ferroelectricity. Landau-Ginzburg theory; displacive and order-disorder transitions, reduced size and boundary effects, antiferroelectricity, piezoelectricity, ferroelasticity.

**Module VII: [5]**

Analogies and difference between ferroelectrics and ferromagnetism; origin of spontaneous polarization, ferroelectric random access memories, Magnetoresistive random access memories, Multiferroics, Magnetoelectric coupling, composites.

**Textbooks:**

**IMP 9015 Non-conventional Energy Resources (3-0-0-3)**

**Module I: Conventional Energy Sources [5]**

World's reserve of commercial energy sources and their availability – various forms of energy – renewable and conventional energy systems – comparison – coal, oil and natural gas – availability – statistical details – applications – merits and demerits.

**Module II: Non-Conventional Energy Sources [5]**

Renewable energy sources – solar energy – nature of solar radiation – components – solar heaters – crop dryers – space cooling – solar ponds, solar cookers – water desalination – photovoltaic generation basics – merits and demerits of solar energy.

**Module III: Direct Energy Conversion [5]**

Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermo-electric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.

**Module IV: Principles of Solar Radiation [5]**

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, Solar radiation on tilted surface, Instruments for measuring solar radiation and sun shine, solar radiation data.

**Module V: Solar Energy Collection [5]**

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/ cooling techniques, solar distillation and drying, Solar Photovoltaic systems-fundamentals, characteristics, classification, solar cell module, panel, array construction, maximum PV O/P and load matching, power point tracker, balance and applications.

**Module VI: [5]**

**Wind Energy** Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

**Bio-Mass** Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation, and economic aspects.

**Module VII: [5]**

**Geothermal Energy:** Resources, types of wells, methods of harnessing the energy potential in India. **Ocean Energy and Hydro Resources:** Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave energy: Potential and conversion techniques, mini-hydel power plants, their economics, Micro-Hydro scheme, water turbine, classifications, characteristics, selection, generators, present status, fuel cell, hydrogen energy, PEM fuel cell.

**References:**


1. Renewable Energy Resources / Tiwari and Ghosal / Narosa
2. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.
3. Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd.
4. Non-conventional energy resources, B. H. Khan, McGraw Hill.

**TNT 2003 Nanophotonics (3-0-0-3)**

**Module I & II: Foundations for Nanophotonics [10]**

Photons and electrons: similarities and differences, freespace propagation. Confinement of photons and electrons. Propagation through a classically forbidden zone: tunneling. Localization under a periodic potential: Band gap. Cooperative effects for photons and electrons. Nanoscale optical interactions, axial and lateral nanoscopic localization. Nanoscale confinement of electronic interactions: Quantum confinement effects, nanoscale interaction dynamics.

**Module III: Quantum Confined Materials [5]**

Inorganic semiconductors, quantum wells, quantum wired, quantum dots, quantum rings. Manifestation of quantum confinement: Optical properties nonlinear optical properties. Quantum confined stark effect. Dielectric confinement effect, superlattices. Quantum confined structures as Lasing media.

**Module IV: Photonic Crystals [6]**

Basics Concepts, Features of Photonic Crystals, wave propagation, photonic bandgaps, light guiding. Theoretical Modeling of Photonic Crystals. Methods of Fabrication. Photonic Crystal Optical Circuitry. Nonlinear Photonic Crystals. Photonic Crystals and Optical Communications. Application to high efficiency emitters, miniaturized photonic circuits and dispersion engineering. Photonic Crystal Sensors.

**Module V: Microstructure Fibers [4]**

Photonic crystal fiber, photonic band gap fibers (PBG), band gap guiding, single mode and multi mode, dispersion engineering, nonlinearity engineering, devices using crystal fibers.

**Module VI: Plasmonics [5]**

Metallic nanoparticles, nanorods and nanoshells, local field enhancement. Collective modes in nanoparticle arrays, particle chains and arrays. surface plasmons, plasmon waveguides. Applications of Metallic Nanostructures.

**Module VII: Nanophotonic Devices [5]**

Resonant cavity quantum well lasers and light-emitting diodes, fundamentals of Cavity QED, strong and weak coupling regime, Purcell factor, Spontaneous emission control, Application of microcavities, including low threshold lasers, resonant cavity LED. Microcavity-based single photon sources.

**Books:**


1. Nanophotonics, Paras N Prasad, John Wiley & Sons (2004)
2. Photonic Crystals: Towards Nanoscale Photonic Devices; Jean Michel Lourtioz, Springer; ISBN 354024431X
3. Fundamentals of Photonic Crystal Fibers; Fredric Zolla-Imperial College Press. ISBN 1860945074
4. Photonic Crystals; John D Joannopoulos, Princeton University Press; ISBN 0691037442
5. Photonic Crystals: Molding the Flow of Light; John D Joannopoulos , R.D. Meade and J.N.Winn, Princeton University Press ( 1995)

**Semester - X**

**IMP 10001 Project / Dissertation** **20 Credits**