

5 Year Integrated M.Sc. Physics

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

**Course Structure and Syllabus for
I.M.Sc Physics
I.M.Sc Total Credits: 212**

Date: 28 September 2015

· Applicable to IMSc Physics 2015 Batch onward.

Course Structure for Five-Year Integrated M.Sc. 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 2101	Physics II (Electricity and Magnetism)	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	1	0	4
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
						24
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 4101	Physics IV (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			L	T	P	Credit
	IMP 5001	Fundamentals of Electronics	3	1	0	4
	IMP 5103	Heat & Thermodynamics	3	0	0	3
	IMP 5107	Introduction to Quantum Mechanics	3	1	0	4
	IMP 5009	Mathematical Physics	3	0	0	3
	IMP 5011	Classical Physics	3	0	0	3
BR	ME 5006	Computer Aided Design Laboratory	0	0	3	2
	IMP5002	Physics Laboratory V	0	0	3	2
						21

Sixth Semester						
	IMP 6101	Materials Science and Nanotechnology	3	0	0	3
	IMP 6003	Digital Electronics	3	1	0	4
	IMP 6107	Introduction to Nuclear Physics	3	1	0	4
	IMP 6009	Introduction to Statistical 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		Course Structure for Two Year M. Sc. in Physics and Course Structure for Five-Year Integrated M. Sc. in Physics: Contd. (M.Sc in Physics and VII, VIII, IX & IX semesters of IMSc Physics are identical/common)	L	T	P	Credit
	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 -I	0	0	3	2
	Total:					20
Eighth Semester						
	SAP 2001	Electronics Devices and Circuits	3	1	0	4
	SAP 2105	Atomic and Molecular Spectroscopy	3	0	0	3
	SAP 2109	Condensed Matter Physics	3	0	0	3
	SAP 2011	Advanced Quantum Mechanics	3	0	0	3
	SAP 2013	Laser Physics and Applications	3	0	0	3
	SAP 2002	Physics Laboratory II - Lasers and Advanced Optics Laboratory	0	0	3	2
	SAP 2004	Physics Laboratory III - Electronics and Instrumentation Laboratory	0	0	3	2
	Total:					20

Ninth Semester						
	SAP 3301	Nuclear and Particle Physics	3	0	0	3
	SAP 3007	Advanced Electrodynamics	3	0	0	3
	SAP 3115	Advanced Experimental Techniques	3	0	0	3
	SAP 3002	Physics Laboratory IV - Advanced Materials Science Laboratory	0	0	3	2
	SAP 3104	Physics Laboratory V	0	0	3	2
	Breadth Paper	PG level of other Departments*	3	0	0	3
		One paper from Either Group A or B or C or D	3	1	0	4
Group A	SAP 3009	Plasma Physics	3	1	0	4
Group B	SAP 3011	Quantum Theory of Solids	3	1	0	4
Group C	SAP 3013	Microwave Electronics	3	1	0	4
Group D	SAP 3017	Fiber and Integrated Optics	3	1	0	4
	Total credits:					20

Tenth Semester		Three papers from any group (Papers shall be chosen from same group in IX and X Semesters)	L	T	P	Credit
		Group-A- Plasma Sciences				
	SAP 4001	Theory of Plasmas	3	1	0	4
	SAP 4003	Plasma Beams and Applications	3	1	0	4
	SAP 4005	Plasma Processing of Materials	3	1	0	4
	SAP 4007	Thin Film and Vacuum Technology	3	1	0	4
		Group-B- Condensed Matter Physics				
	SAP 4009	Physics of Solid State Devices	3	1	0	4
	SAP 4011	Advanced Materials Science	3	1	0	4
	SAP 4013	Nonconventional Energy Materials	3	1	0	4
	SAP 4015	Physics of Thin Films	3	1	0	4
		Group-C- Electronics				
	SAP 4009	Physics of Solid State Devices	3	1	0	4
	SAP 4019	Microprocessors and Microcontrollers	3	1	0	4
	SAP 4021	Instrumentation and Control	3	1	0	4
	SAP 4023	Integrated Electronics	3	1	0	4
	SAP 4017	Optical Communications	3	1	0	4
		Group-D- Photonics				
	SAP 4017	Optical Communications	3	1	0	4
	SAP 4027	Quantum & Nonlinear Optics	3	1	0	4
	SAP 4029	Introduction to Nanophotonics	3	1	0	4
	SAP 4031	Photonic and Optoelectronic Devices	3	1	0	4
	SAP 4033	Holography and Applications	3	1	0	4
	IMP-10001	Project / Dissertation				08
		Total				20
Total credits of IMSc						212
Total credits of MSc						80

IMSc Physics I Semester

IMP 1001 Physics-I General Properties of Matter, Waves & Oscillations

[3-1-0-4]

Module I: Systems of particles: Centre of mass, Linear momentum, Conservation of linear momentum, System with varying mass: A Rocket; Work and Kinetic Energy Theorem, Potential energy and conservation of energy, Conservative and non-conservative forces, Force as gradient of potential energy; Particle collisions: Elastic and inelastic collision, Centre of Mass and Laboratory Frames. [8]

Module II: 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 for bar, circular disc and solid cylinder. [6]

Module III: The world and gravitational force, Newton's law of gravitation, Gravitation near earth's surface, Gravitation inside earth, Gravitational potential energy, Escape speed, Planets and satellites: Kepler's Laws. [6] **Module IV:** Hooke's Law, Young's Modulus, Bulk Modulus, Shear Modulus, Elastic energy in different types of deformation, Torsion of a cylinder, Strain Energy in a twisted cylinder, Bending moment, Cantilever, Beam supported at both ends, Beams clamped at both ends. [6]

Module V: Molecular forces, Surface tension and surface energy, Angle of contact, Excess pressure over a curved liquid surface (drops and bubbles), Capillarity, Viscosity and Coefficient of viscosity, Laminar flow, Streamline and turbulent motion, Reynold's number; Poiseuille's equation, Stokes' law, Rotating cylinder and rotating disc methods for determining the coefficient of viscosity, Energy of the fluid, Euler's equation for liquid flow; Bernoulli's theorem and its applications. [8]

Module VI: Simple harmonic motion, Motion of simple and compound pendulum. Damping, Forced vibration and resonance, Wave equation in one dimension, Phase velocity, Group velocity, Dispersion. [8]

Module VII: 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, principle of superposition for waves, Interference of waves, Stationary waves, Sound waves, speed of sound Intensity of sound. Measurement of intensity; beats and applications, the Doppler effect, Shock waves. [8]

Textbooks:

1. Mechanics by R.K. Shukla. and A. Srivastava New Age International
2. Elements of Properties of Matter: by D. S. Mathur, Publisher: S Chand & Co.

Reference Books:

1. Sears and Zemansky's University Physics by H.D.Young, R.A.Freedman, A.L.Ford, Publisher: Pearson
2. Fundamental of Physics, by Halliday D., Resnick R. and Walker J., Publisher: Wiley India
3. Mechanics by D.S.Mathur and P. S. Hemne, Publisher: S Chand & Co.
4. Waves and Oscillations by A. P. French, Publisher: CBS Publishers & Distributors

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 NH₃, H₃O⁺, SF₄, ClF₃, ICl₂ and H₂O. 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 cholesteric 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 KMnO₄, allylic substitution by NBS. Conjugated Dienes; Electrophilic addition of dienes: 1,2, & 1,4 addition, Diels . Alder reaction

Books :

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

IMSc Physics I Semester

IMM 1001 Mathematics I - Analytical Geometry and Calculus

[3-1-0-4]

Module I: Analytical Geometry (2D & 3D)

Polar equation of conics. Cones, cylinders and conicoids, Central conicoids, normals and conjugate diameters. [6]

Module II & III: Differential Calculus [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 Ed n. , 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

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

IMSc Physics I Semester

IMP 1002: Physics Laboratory-I (General Physics)

[0-0-3-2]

1. Basics of laboratory work:
 - a. Safety precautions for experimenters and essential first aid
 - b. Acquiring data, eye-estimation in reading instruments, graph plotting, best fit line and curve
 - c. Error analysis, standard deviation, standard error, regression, correlation
 - d. Know your measuring instruments: (i) reading micrometer scale and vernier scale; (ii) handling spectrometer, power supply, function generator, CRO
2. Determination of moment of inertia of objects of regular shapes (rod, sheet, cylinder, sphere, spherical shell) and verification of parallel and perpendicular axes theorems.
3. Study of time-period variation of a simple pendulum for large oscillation angles.
4. Determination of acceleration due to gravity using Kater's pendulum
5. Determination of momentum of an iron ball using ballistic pendulum
6. Determination of Young's modulus, of material of a thin wire using vernier apparatus.
7. Determination of Young's modulus of material of a metallic bar by bending of beam method.
8. Determination of modulus of rigidity by Barton's apparatus.
9. To study the standing waves on a stretched string and verify the relation between tension, frequency and number of loops.
10. Determination of angle of contact for water and mercury with glass.
11. Determination of surface tension and its variation with temperature of a liquid by capillary tube method.
12. Determination of surface tension determination using Jaeger's method.
13. Determination of viscosity of liquid using Poiseuille's method.
14. Measuring velocity of sound by Lissajous figures method

IMC 1002: Chemistry Laboratory-I

[0-0-3-2]

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
Acetanilide 113.5-114 C, m-Dinitrobenzene 90 C
p-Dichlorobenzene 52 C, Aspirin 135 C
5. Determination of Boiling Point
 - a. Ethanol 78 C, Cyclohexane 81.4 C, Toluene 110.6 C
6. Crystallization
 - a. Phthalic acid from hot water (using fluted filter paper and stemless funnel)
 - b. Acetanilide from boiling water
 - c. Naphthalene from ethanol
 - d. Benzoic acid from water
7. Distillation
 - a. Simple distillation of ethanol-water mixture using water condenser
 - b. Distillation of nitrobenzene and aniline using air condenser
8. Macro analysis (qualitative) of cations and anions (known samples)

Books Suggested:

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

IMSc Physics -II Semester

IMP 2101 Physics II (Electricity and Magnetism)

[3-0-0-3]

Electrostatics: Coulomb's law, Gauss's Law (integral and differential forms), electric field and potential and, electrostatic energy density, Capacitors and guard ring, lightning conductor, gold leaf electroscope, Attracted disc electrometer, Van de Graff generator, electrostatic lens for focusing of electron beams.

[5]

Magnetism: Biot-Savart law, Gauss's Law (integral and differential forms), Lorentz force, Hall effect, magnetometers, dip circle, earth inductor, dia para ferro magnetism, magnetic properties of earth. [5]

Thermoelectricity and Chemical effect: Seebeck, Peltier and Thomson effect, thermopile, bolometer, Primary and secondary cells, standard cell, electroplating, lead-acid accumulator. [4]

Electrical Measurements: Dead beat galvanometer, ballistic galvanometer, tangent and moving coil galvanometer, wattmeter, energy meter, hot wire instruments, Shunts. [4]

Direct current: Ampere's circuital law (integral and differential forms), Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Maxwell's current loop method, dc bridges. [5]

Electromagnetism: Faraday's law of electromagnetic induction (integral and differential forms), Lenz's law, Inductance, Self and mutual induction, Ruhmkorff's coil, magnetic energy density, continuity equation for charge, displacement current, Maxwell's field equations in free space. Growth and decay of current in LR, CR, LCR circuits, analogy with spring mass system, free, damped and forced oscillations, High-Q systems. [10]

Alternating currents: Passage of ac through LR, CR, LCR series and parallel, power in ac circuits, power factor, wattless current, phasors, electrical machines, choke, non-inductive coil, transformer and losses, Eddy currents, hysteresis, ac / dc – motor starter, generator, ac transmission, ac bridges. [7]

Textbook:

1. Edward M. Purcell, David J. Morin, Electricity and Magnetism, Cambridge University Press

References:

1. David J. Griffiths, Introduction to Electrodynamics (3rd Edition), Prentice Hall Inc.
2. Halliday, Resnick and Walker, Fundamentals of Physics, Vol.-2, Wiley India Pvt. Ltd.
3. Reitz, John R.; Milford, Frederick J.; Christy, Robert W. (2008), Foundations of Electromagnetic Theory (4th ed.), Addison Wesley
4. Sadiku, Matthew N. O., Elements of Electromagnetics (4th ed.). Oxford University Press

Module-I: Colloidal State [5]

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

Module-II: Chemical kinetics and Catalysis [6]

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

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

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

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

Module-IV: Acids and Bases [4]

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

Module-V: Aromatic Compounds & Aromaticity [5]

Aromatic hydro carbons and aromaticity, resonance in benzene, Huckel's $(4n+2)$ rule and its simple applications. Acidic character of phenols - explanation on the basis of resonance stabilization.

Electrophilic substitution reactions in aromatic compounds. General mechanisms of nitration, halogenation, sulphonation, Friedel-Craft's acylation and alkylation, ortho/para/meta directive influence with examples.

Module-VI: Elimination & Substitutions Reactions [5]

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

Module-VII: Stereochemistry [6]

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

Books Recommended:

1. Fundamentals of Organic Chemistry Solomons, John Wiley
2. Introduction to Organic Chemistry, Streitwieser, 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

IMSc Physics II Semester

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 ineq uality, 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.

IMSc Physics II Semester

CS 2301 Fundamentals of Data Structures

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, Apriori 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.

IMSc Physics II Semester

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, wet 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.

IMSc Physics II Semester

IMP 2002 Physics Laboratory-II

[0-0-3-2]

IMC 2002 Chemistry Laboratory-II

[0-0-3-2]

IMSc Physics -III Semester

IMP 3001 Physics III - Modern Physics

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, Oppenauer oxidation. Reactions of aldehydes and ketones (Reduction using $LiAlH_4$, 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, Gabrielphthalimide 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

IMSc Physics -III Semester

IMM 3001 Mathematics III-Ordinary Differential Equations with Special Functions

[3-1-0-4]

Module I: Differential Equations [6]

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

Module II: [6]

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

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, Parseval'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

IMSc Physics -III Semester

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.

IMSc Physics -III Semester

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 Terpenoids 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 Lab III (Modern Physics)

[0-0-3-2]

1. Determination of solar cell efficiency.
2. Planck's constant determination using LED.
3. Boltzmann constant determination using pn junction diode
4. Band-gap determination using pn junction diode
5. Thermionic emission using vacuum tube
6. Determination of specific charge of electron by Millikan's oil drop method
7. Determination of specific charge of electron by Thomson's method
8. Verification of laws of photoelectric effect
9. To perform qualitative observations of Zeeman Effect
10. Study of atomic spectra of hydrogen, helium, neon, sodium and mercury (any two sources at least)
11. Experiments with cathode ray tubes
 - a. Observing the positive rays
 - b. Observation of various properties of cathode rays
12. Production of spectrum and comparison of spectrometers (Prism, Pellin-Broca prism, grating)
13. Line-width of a He-Ne laser using monochromator
14. Radiance of various surfaces in thermal equilibrium (Liesle's cube)
15. Scattering of laser light by dust particles and their average size estimation.
16. Verification of Stefan's law
17. Optical alignment of prism spectrometer
18. Minimum deviation using prism spectrometer.

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 R_f values and identification of organic compounds.
 - a. Separation of green leaf pigments (spinach leaves may be used).
 - b. Preparation and separation of 2,4-dinitrophenylhydrazones 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. R_f 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.

CS 3102 Java Programming Laboratory (0-0-3-2)

IMSc Physics -IV Semester**IMP 4101 Physics IV - Optics****Modules I & II: Geometrical Optics:**

Introduction to geometrical and physical optics, Fermat's principle of least action, reflection, refraction, refraction through spherical surfaces, conjugate foci for refraction at a spherical surface, transverse and longitudinal magnification of image formed by a spherically refracting surface, Lagrange and Helmholtz Laws of magnification, refraction through convex lens, deviation produced by a thin lens, introductory idea of thick lens. cardinal points, lenses separated by a finite distance and equivalent focal length, graphical construction of images using cardinal points, optic centre of a lens. [10]

Module III: Aberrations

Spherical aberrations, minimizing spherical aberration, chromatic aberration, condition for achromatism, coma, astigmatism, curvature of the field, Huygen's and Ramsden's eye pieces. [4]

Module IV & V Interference

Conditions for sustained interference, theory of interference, Two-Beam Interference, Interference in parallel and wedge shaped films, Achromatic fringes, Color of thin films. Newton's rings and Michelson interferometer and their applications. Multiple beam interference in parallel film and Fabry-Perot interferometer, limit of resolution. [10]

Module VI: Diffraction

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

Module VII: Polarization

Polarization of light, Malus 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. [10]

Textbooks:

1. Fundamentals of Optics - Jenkins and White; McGraw-Hill
2. Optics - A. Ghatak; Tata McGraw-Hill Education

Reference books:

1. Optics - Hecht and Zajak; Addison-Wesley Pub. Co.

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.

IMSc Physics -IV Semester

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.

Text books:

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

Reference Books:

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.

IMSc Physics -IV Semester

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,

IMSc Physics -IV Semester

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. Madelung constant, evaluation of Madelung constant for NaCl structure.

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.

Text books:

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

IMSc Physics -IV Semester

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 η 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 λ_{\max} for KMnO_4 by colorimetric measurements
5. Determine the surface tension of a liquid by stalagmometer method
6. Determine the Viscosity of a given liquid by Oswald's Viscometer.
7. To study the distribution of benzoic acid between benzene and water at room temperature and hence show the molecular state of benzoic acid in benzene.
8. Determine the heat of neutralization of HCl by NaOH.
9. Study the hydrolysis of an ester in presence of HCl.

Recommended books:

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

IMSc Physics -V Semester

IMP 5001 Fundamentals of Electronics

[3-1-0-4]

Module I: Network theorems

[5]

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

Module II: Devices

[6]

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

Module III: Amplifiers

[11]

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

[5]

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

Module V: Communication principles

[10]

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

[5]

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

Module VII: Power Supplies

[8]

Half and full wave rectifiers, efficiency and ripple factor; filters (C, L, pi), Regulated power supply using Zener diode, series pass regulator and series pass regulator with op-amp feedback.

Text books:

1. Electronics Fundamentals 7/e, T. L. Floyd, Pearson International Edition
2. Engineering Electronics, J. D. Ryder, McGraw Hill Book Company

Module I: Concept of heat and temperature, Conduction of heat, Measurement of temperature, thermometers and thermocouple, Kinetic theory of gases; Basic assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. [6]

Module II: 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. Real gases, Andrew's curves, Equation of state, Virial coefficients, Van der Waals equation, Critical constants. [6]

Module III: Thermal conductivity and diffusivity; Fourier equation for the propagation of heat and its steady state solution for rectilinear flow of heat; cylindrical flow of heat; various experiments for measurement of thermal conductivity for good and bad conductors. [6]

Module IV:

Basic concepts of thermodynamics: macroscopic and microscopic points of view of thermodynamics, Thermodynamic systems and thermodynamic equilibrium, Thermodynamic state of a system and Zeroth law of Thermodynamics, Thermodynamic Equilibrium, Adiabatic and isothermal changes, Work done during isothermal changes, Adiabatic relations for perfect gas, Work done during adiabatic change, Indicator Diagram. [5]

Module V:

Laws of thermodynamics: The first law of thermodynamics, Reversible and irreversible processes; Conversion of Heat into Work and its converse, Carnot's Cycle and Carnot's Heat Engine and its efficiency, Second law of Thermodynamics, Concept of Entropy, T-dS Equation, Clausius-Clapeyron Latent heat equations, Nernst heat theorem and the third law of thermodynamics. [6]

Module VI:

Thermodynamic functions: Internal energy, Helmholtz free energy, Specific heat, Gibb's free energy and enthalpy functions. [5]

Module VII:

Radiation: Concept of radiation, emissive and absorptive power of different bodies, black body radiation, Kirchhoff's law, pressure of radiation, the Stefan-Boltzmann law, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory of radiation. [6]

Text books:

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)

IMSc Physics -V Semester

IMP 5107 Introduction to Quantum Mechanics

[3-1-0-4]

Module I: Inadequacy of classical physics, black body radiation, Planck's law of radiation, origin of quantum theory, Specific heat of solids, Debye's theory, Photoelectric effect, Einstein's equation, Compton effect, de Broglie's hypothesis, wave-particle duality, Bohr's theory of Hydrogen atom, Franck-Hertz experiment. Bohr's correspondence principle, Davisson Germer experiment, Thomson's experiment. **[8]**

Module II: Concept of wave function, probability density and normalization. Free particle wave function, Dirac delta-function representation, Gaussian wave packet, Propagation of wave packets, concept of phase and group velocity, spread of wave packet. **[6]**

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

Module IV: Operator formalism in Quantum mechanics, Expectation value, Probability currents and their relation with the flux in beam of particles. **[5]**

Module V: Schrödinger time-independent and time-dependent equations, concept of stationary states, eigen functions, degeneracy, One dimensional potential problems: particle in a box, bound states in infinite square potential well, penetration through a potential barrier, alpha decay. **[6]**

Module VI: Linear harmonic oscillator (qualitative), classical and quantum probability densities, eigen values and wave functions, Energy eigen functions in position space. **[5]**

Module VII: Angular momentum operators, eigen values and eigen functions, various commutation relations, spin angular momentum, Pauli's Exclusion Principle (qualitative). **[5]**

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

IMSc Physics -V Semester

IMP 5009 Mathematical Physics

[3-0-0-3]

Module I: Matrix Algebra [6]

Matrix algebra, addition, subtraction, multiplication by a scalar, Matrix inversion, Definition of different types matrices.

Modules II and III: Vector analysis

[10]

Scalar and vector fields, Differential Vector Operators, Expression of gradient, divergence and curl in Cartesian, spherical and cylindrical coordinates. Vector Integrations, Gauss' theorem, Green's theorem, Stoke's theorem. Elementary ideas about Tensors: Definition of tensor, Covariant and contravariant tensors.

Module IV: Gamma and Beta functions

[6]

Definitions and their special forms, Relation between Gamma and Beta functions.

Module V: Differential equations of first order

[6]

Order and degree of a differential equations, Geometrical meaning of the differential equation of first order and first degree, variables separable, homogeneous differential equations.

Module VI: Fourier Series

[6]

General Properties, Applications of Fourier series.

Module VII: Complex variables

[6]

Analytic functions, Cauchy's Integral theorem, Singularities, Residue theorem.

Text books:

Mathematical Methods in Physics: Arfken, Weber & Harris

Mathematical Physics: Dass & Verma.

IMP 5011 Classical Physics

[3-0-0-3]

Module I

[6]

Mechanics of Point Particle: Coordinate systems, scalar and vector fields, gradient, divergence and curl, Review of Newtonian mechanics: space and time, inertial frames, and non-inertial frames, fictitious force, conservations laws, work energy theorem.

Module II

[6]

Non-relativistic particle dynamics: Equation of motion of an uncharged particle, charged particle in a uniform and constant electric field, charged particle in an alternating electric field, charged particle in a uniform and constant magnetic field, charged particles in a combined electric and magnetic field, cyclotron, magnetic lens.

Module III

[5]

Coupled Oscillator: Equation of motion of coupled system of two pendulums, total energy of two identical coupled pendulums, type of coupling, method of finding normal mode frequencies, exchange of energy between two normal modes, inductively coupled circuit.

Module IV

[7]

Dynamics of a Rigid Body: Degree of freedom, constraints, forces of constraints, generalized coordinates, rigid body and space reference system, Euler's angles, angular momentum and inertia tensor, principals moment of inertia, rotational kinetic energy of rigid body, symmetric bodies, moments of inertia for different body system, Euler's equation of motion for a rigid body by Newtonian method.

Module V

[6]

Lagrangian and Hamiltonian formulation of Classical Mechanics: Basic idea of Lagrangian and Hamiltonian dynamic, principle of virtual work, D'Alembert principle, Lagrange equation of motion from D'Alembert principle, generalized momentia and cyclic coordinates, Hamiltonian function, Hamiltons's Equations.

Module VI & VII

[10]

Special Theory of Relativity: Galilean transformation, principle of relativity, transformation of force in one inertial system to another, covariance of physical laws, The Michelson Morley experiment, postulates of special theory of relativity, Lorentz Transformations, length contraction and time dilation using Lorentz Transformations.

Textbooks:

1. Mechanics by R.K. Shukla. and A. Srivastava New Age International.
2. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rdEdn. 2002, Pearson Education.

Reference Books:

3. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
4. Classical Mechanics by P. V. Panat, Narosa Publishing Home,, New Delhi.

IMSc Physics -V Semester

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 selection 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.

Text 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.

IMSc Physics -V Semester

IMP 5002 :Physics Lab V [Electronics]

[0-0-3-2]

1. Verification of (any two)
 - Thevenin's
 - Norton's
 - Maximum power transfer theorem
2. Operation and characteristics of electronic devices (any six) –
 - Diode; LED; Zener;
 - BJT; FET; MOSFET; •
 - SCR; Triac; Diac;
 - Tunnel diode; Varactor diode; Varistor; Photocell, photodiode
3. Determination of ripple factor of half wave rectifier,
 - full wave rectifier
 - bridge rectifier
4. Determination of ripple factor with
 - capacitor input filter,
 - inductor input filter, •
 - L-section and
 - π -section
5. Study a Zener regulator and a
6. 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. Astable multivibrator using two transistors
12. Astable multivibrator using NE555
13. Astable multivibrator using op-amp $\mu A 741$
14. Inverting amplifier using op-amp $\mu A 741$
15. Non-inverting amplifier using op-amp $\mu A 741$
16. Summing amplifier using op-amp $\mu A 741$
17. Difference amplifier using op-amp $\mu A 741$
18. Integrator using op-amp $\mu A 741$
- differentiator using op-amp $\mu A 741$

IMSc Physics -VI Semester

IMP 6101 Materials Science and Nanotechnology

[3-0-0-3]

Module I: Imperfections and strengthening mechanisms in solids [6]

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 [6]

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 [6]

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 [6]

Traditional ceramics, general properties, types, applications. Advanced ceramics, properties and applications, Glasses, general properties, types, applications,

Module V: Polymers and Composites [6]

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

[6]

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

[5]

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

[12]

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

[6]

ROM, RAM, PROM, EROM, EEPROM, static and dynamic RAM.

Module VII: Data converters

[12]

Digital to Analog Conversion, R-2R ladder type DAC, Weighted resistor type DAC, Switched current source type DAC, Switched capacitor type DAC, Analog to Digital Conversion, Counter type A/D converter, Flash type A/D converter, Dual slope A/D converter, Successive approximation ADC.

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

IMSc Physics -VI Semester

IMP 6107 Introduction to Nuclear Physics

[3-1-0-4]

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. [6]

Module II: Radioactivity

Types of atomic nuclei (isotopes, isotones, isobars), laws of radioactivity decay, alpha and beta decay, half-life of radioactive nuclide, average life of an atom, successive radioactive transformation, radioactive equilibrium, applications, tracers, radioactive dating. [6]

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. [6]

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. [6]

Module V: Nuclear Energy

Fissionable and fissile materials, Fission reactors, breeding, Fusion processes in stars, conditions for controlled thermonuclear reactions, Lawson criteria. [8]

Module VI: Nuclear Detectors

Ionization chamber, proportional counter, Geiger-Muller counter, scintillation counter, semiconductor counter. [8]

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, linear accelerator, Cyclotron. [10]

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

IMSc Physics -VI Semester

IMP 6009: Introduction to Statistical Physics

[3-0-0-3]

Module I:

[6]

Laws of Thermodynamics, Statistical definition of temperature, pressure, Entropy, chemical potential, Thermodynamics functions, Microstates & macrostates, Calculation of number of microstates in a macrostates, Stirling approximation, Fundamental postulates of statistical mechanics.

Module II:

[5]

Distinguishable particles, Boltzmann distribution law, partition function, calculation of thermodynamics quantities of an array of simple harmonic oscillators (1-dimension); Einstein's model of crystalline solid,

Module III:

[7]

Indistinguishable particles, Maxwell-Boltzmann distribution of indistinguishable particles, partition function of indistinguishable particles, Statistical representation of Thermodynamic quantities, ideal monoatomic gas, Equation of state, Calculation of thermodynamic quantities for ideal monoatomic gas, Gibbs Paradox.

Module IV:

[5]

Concept of Phase space & quantum state, Liouville's Theorem, Fluctuations, Time average and Ensemble average of a Physical quantity, Microcanonical distribution, Entropy and statistical weight.

Module V:

[6]

Canonical ensemble: distribution function, Partition function and thermodynamical functions. Grand ensemble distribution function, Grand partition function and thermodynamical functions.

Module VI:

[6]

Fermi-Dirac statistics: Fermi distribution at zero and non-zero temperatures, Fermi energy and its expression in terms of particle density. Degenerate and non-degenerate Fermi gas. Electron specific heat of metals at low temperature.

Module VII:

[5]

Bose-Einstein statistics: Application to radiation – Planck's law. Rayleigh Jeans and Wien laws as limiting cases. Stefan's law.

Text books:

1. Introduction to Statistical Mechanics: S. K. Sinha (Narosa Publications)
2. Statistical Mechanics: An Introduction: E. Guha (Narosa Publications)
3. Statistical Mechanics: R. K. Patharia (Butterworth Heinemann)
4. Statistical Mechanics: Kerson & Huang (Wiley Publications).

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

IMSc Physics -VI Semester

MSH 1145 Foreign Language (German-I)

[3-0-0-3]

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, wohnen? – wo? – wohin? Präpositionen 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.

IMSc Physics -VI Semester

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 magneto-resistance 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 Quincke'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

I.M.Sc Physics-VII-Semester/M.Sc Physics-I Semester

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

[7]

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

[9]

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.

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester

SAP 1003 Electrodynamics

[3-0-0-3]

Modules I & II: Electrostatics

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. [13]

Modules III & IV: Magnetostatics, Time Varying Fields and Maxwell's Equations

Foundations of Magnetostatics, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Maxwell's displacement current. Maxwell's field 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. [12]

Modules V, VI & VII: Solutions of Maxwell's Equations and Radiation

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. [15]

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

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester

SAP 1005 Classical Mechanics and Relativity

[3-0-0-3]

Modules I: Constrained Motion

Constraints, Classification of Constraints, Principal of Virtual Work, D'Alembert's principal and its applications. [5]

Modules II: Lagrangian formulation

Generalized coordinates, Lagrange'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. [6]

Modules III: Hamilton's formulation

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. [4]

Modules IV: Canonical Transformations & Poissons Bracket: Generating function, Conditions for canonical transformation and problem. Poisson Brackets, its definitions, identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity, (statement only), invariance of PB under canonical transformation. Lagrange bracket. [10]

Modules V: Rotational Motion

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

Modules VI: Central Force

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

Modules VII: Relativity

Special theory of relativity, Lorentz's transformation, covariant four-dimensional formulations, force and energy equations in relativistic mechanics. [5]

Textbook:

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

References:

1. Classical Dynamics of Particles and Systems by Marion and Thomson, 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]

Module I & II: Schrödinger wave equation, interpretation of wave function, probability current density. Ehrenfest's theorem, one dimensional finite square well and barrier. Linear vector space, Dirac Bra-Ket notations. Determination of eigen-values and eigen-functions using matrix representations. Coordinate and momentum representation. Uncertainty principle. [10]

Module III: Linear harmonic oscillator, Heisenberg and quantum mechanical treatments. Asymptotic behavior, energy levels, correspondence with classical theory. Spherically symmetric potential in three dimensions, hydrogen atom, wave functions, eigenvalues, degeneracy etc. [9]

Module IV & V: Theory of angular momentum, symmetry, invariance and conservation laws, relation between rotation and angular momentum. Commutation rules, eigenvalues and eigen functions of the angular momentum. Stern-Gerlach experiment, spin, spin operators, Pauli's spin matrices. Spin states of two spin-1/2 particles. Addition of angular momenta, Clebsch-Gordon coefficients. Principle of indistinguishability of identical particles, Pauli's exclusion principle. [12]

Module VI: Scattering Theory, differential and total scattering cross-section laws, partial wave analysis and application to simple cases; Integral form of scattering equation, Born approximation validity and simple applications. [5]

Module VII: WKB approximation, solution near a turning point, connection formula, tunneling through barrier. boundary conditions in the quasi classical case. [4]

Book:

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

References:

1. Quantum Mechanics by L. D. Landau and E. M. Lifshitz (Pergamon, Berlin)
2. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (McMillan India)
3. A Textbook of Quantum Mechanics by P. T. Mathews (Tata McGraw Hill)

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester**SAP 2007 Statistical Physics****Modules I & II: Formalism of Equilibrium Statistical Mechanics**

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. [8]

Modules III & IV: Quantum Statistics

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. [8]

Module V: Phase Transitions and Critical Phenomena

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. [8]

Module VI: Ising Model

Ising Model, mean-field theory, exact solution in one dimension, renormalization in one dimension. [8]

Module VII: Nonequilibrium Systems

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. [8]

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

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester

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. Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India (1983)
2. Numerical Methods for Engineering, S.C. Chopra and R.C. Canale, McGraw-Hill (1989).
3. Numerical Methods for Scientists and Engineers, Prentice Hall of India (1988).

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester

SAP 1004: Physics Laboratory- I [Advanced Physics]

[0-0-3-2]

1. Error handling and analysis.
2. Fourier analysis of various waveforms [Sinusoids, Composition of sinusoids, Square, triangle, Sawtooth, Ramp, Staircase, Modulated signals with change in modulation index (AM, FM, PM, ASK, FSK), Noises] using AWG and DSO.
3. Study of the construction, working and operation of different components in a vacuum system.
 - A. Determination of pump down time and pumping speed of a rotary vane pump and oil diffusion pump
 - B. Estimation of leak rate of a vacuum system
 - C. Determination of conductance of vacuum lines
4. A comparative study on determination of resistivity and TCR of a given metal sample using two point probe and linear four point probe technique (using a self designed constant current source).
5. Determination of thin film thickness using Tolansky interferometric technique and estimate the flatness of a glass plate
6. Fabrication of a thermocouple and its calibration for use in the determination of melting point of Sn-Pb alloy.
7. Study of hysteresis of steel, mild steel and ferrite samples.
8. To study series and parallel LCR circuit and show the results of variations in R, L and C
9. Study of (a) L-R (b) C-R and (c) L-C-R transients and determination of damping and time constants using DSO
10. Thomson's e/m experiment using cathode ray tube.
11. Thomson's e/m experiment
12. Millikan's oil drop experiment for the determination of specific charge.
13. Determination of Lande-g factor of a paramagnetic sample using electron spin resonance
14. Experiments on radioactivity using Geiger-Muller counter
 - a. G.M. Counter - characteristics, Inverse square law.
 - b. Measurement of dead time of a Geiger-Muller counter
 - c. End point energy and Absorption coefficient using G.M.tube.
 - d. G.M. Counter - Absorption co-efficient.
15. Determination of resolving power of prism spectrometer.
16. Calibration of a Czerny-Turner Monochromator and determination of laser line width.
17. Determination of Rydberg's constant using spectrum from a hydrogen source
18. Study of transformer efficiency and losses using ac wattmeter

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2001 Electronics Devices and Circuits

Electronic Devices

[3-1-0-4]

Varactor diode, photo-diode, Schottky diode, solar cell, Principle of Operation and I-V Characteristics of MOSFET. Thyristors (SCR, LASCR, Triac and Diac).

[7]

Amplifiers using discrete devices

[8]

BJT amplifiers, h-parameters and their variations. Low frequency and high frequency (hybrid-pi model), small signal analysis of BJT amplifiers in CE and CC modes with reference to gain, input and output impedance, gain-bandwidth product, stability and distortion in BJT amplifiers, cascaded multistage amplifiers and cascode amplifiers. Amplifiers using FETs, MOSFETs and their analysis,

Feedback in amplifiers

[9]

Characteristics of Negative Feedback Amplifiers, Input Resistance, Output Resistance, Method of Analysis of a Feedback Amplifier, Voltage Series Feedback, Voltage Series Feedback Pair, Current Series Feedback, Current Shunt Feedback, Voltage Shunt Feedback, Bode Plots, Nyquist plots, two-pole and three-pole transfer function with Feedback, Approximate Analysis of a multipole feedback amplifier, Stability, Gain and Phase Margins, Compensation, Dominant-Pole Compensation, Pole-Zero Compensation,

Audio and Radio Frequency Oscillators

[5]

Sinusoidal Oscillators, Phase-Shift Oscillator, Resonant Circuit Oscillators, Radio frequency oscillators: Hartley, Colpitt, Clapp and crystal oscillators (including analysis)

Operational amplifiers

[7]

Differential Amplifier, Emitter-Coupled Differential Amplifier, Transfer Characteristics of a Differential Amplifier, operational Amplifier offset error voltages and currents, temperature drift of input offset voltage and current, Measurement of Operational Amplifier Parameters, Frequency Response of Operational Amplifiers, Dominant-Pole Compensation, Pole-Zero Compensation, Lead Compensation, Step Response of Operational Amplifiers

Linear applications of op-amps

[8]

Op-amp circuits: voltage gain, input impedance, output impedance and bandwidth of inverting amplifier, noninverting amplifier; phase inverter, scale changer, integrator, differentiator. voltage multiplier, limiter, clipper, clamper and peak-to-peak detector, difference amplifier, instrumentation amplifier, log and anti-log circuits, precision rectifiers, active filters (low-pass, high-pass, band-pass, band-reject/ notch), Analog computation circuits, RC phase shift and Wein bridge oscillators.

Nonlinear applications of op-amps

[6]

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.

Textbooks:

1. Electronic Devices: Solid State Electronic Devices – B. G. Streetman, PHI
2. Physics of Semiconductor Devices – S. M. Sze.
3. Integrated Electronics, Jacob Millman and Christos C. Halkias, - Tata McGraw Hill Publication
4. Electronic Devices and Circuit Theory, R. Boylestad and L. Nashelsky
5. Operational Amplifiers and Linear Integrated Circuits - R. F. Coughlin, F. F. Driscoll, PHI,
6. Operational Amplifiers and Linear Integrated Circuits - R. A. Gayakwad, PHI.

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.

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2105 Atomic Molecular Spectroscopy

[3-0-0-3]

1. 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 [6]

2. Molecular Spectroscopy: Concept of spectroscopy, Types of molecular spectroscopy, applications, Rotational, vibrational and electronic spectra of diatomic molecules; Frank – Condon principle and selection rules. Molecular hydrogen, Fluorescence and Phosphorescence, electronic spectroscopy of molecules of diatomic and polyatomic. [6]

3. Characterization of electromagnetic radiation, quantization, regions of spectrums, spectra representation, basic elements of practical spectroscopy, resolving power, width and intensity of spectral transition, Fourier transform spectroscopy, concept of stimulated emission. [5]

4. Microwave and Infra Red spectroscopy: Rotation of diatomic and polyatomic molecules, Instrumentation of Microwave spectroscopy, applications. Born-Oppenheimer approximation, vibrations of diatomic and polyatomic molecules, Instrumentations of IR and its applications. [6]

5. Raman Effect, Rotational Raman spectra. Vibrational Raman spectra. Stokes and anti-Stokes lines and their Intensity difference, Instrumentation and applications. [7]

6. NMR Spectroscopy: Nuclear spin, nuclear resonance, saturation, chemical shift, spin-spin interaction, coupling constant, instrumentation and applications. [5]

7. Mass Spectroscopy: Ion production, fragmentation, ion analysis, ion abundance, mass spectroscopy, instrumentation and application. [5]

Suggested Books:

1. "Introduction to Atomic Spectra", H.E. White, McGraw-Hill.
2. "Fundamentals of Molecular Spectroscopy" C. N. Banwell & E. M. McCash, Tata McGraw-Hill
3. "Atomic Physics", G. P. Harnwell & W.E. Stephens, McGraw-Hills Book Company, Inc.
4. "Modern Spectroscopy", J. M. Hollas, John Wiley
5. Prospective of Modern Physics by A. Beiser.

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2109 Condensed Matter Physics

[3-0-0-3]

Module I&II: Crystal Structure [10]

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. Structure determination using Laue, powder crystal and rotating crystal methods.

Module III: Lattice vibrations [6]

Classical and Einstein theory of specific heat(self study), Debye theory of specific heat, the density of states in 1D and 3D, elastic waves, concept of phonons, vibration of lattice- mono and diatomic chains.

Module IV: Energy band theory [6]

Classical free electron theory and failure. Wave mechanical treatment of electron in a box, electrons in a periodic potential, Bloch's theorem, Kronig-Penney Model, crystal potential, periodic and nonperiodic potential, Brillouin zones, energy band structure in conductors, semiconductors, insulators, Fermi-Dirac distribution, Fermi energy density of states, Fermi surface, effective mass.

Module V: 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 VI: 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 VII: Superconductivity [6]

Meissner effect, type-I and type-II superconductors (SS). London equation, penetration depth, superconducting transitions, optical properties, Cooper pair, BCS theory (Qualitative), coherence length, electron-phonon interaction, flux quantization, Josephson junction, high T_c superconductors.

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

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2011 Advanced Quantum Mechanics

[3-0-0-3]

Module I & II: Perturbation theory, time-independent perturbation theory (non-degenerate and degenerate) and applications. Stark effect and other simple cases. Relativistic perturbation to hydrogen atom. Energy levels of hydrogen including fine structure, Lamb shift and hyperfine splitting. Zeeman effect (normal and anomalous) time, first and second order, the effect of the electric field on the energy levels of an atom (Stark effect). **[12]**

Module III: Quantum mechanics of molecules, Born-Oppenheimer approximation **[6]**

Module IV & V: Time-dependent perturbations , first order transitions, Semi- classical theory of interaction of atoms with field. Quantization of radiation field. Hamiltonian of field and atom, Fermi golden rule, the Einstein's A & B coefficients. **[8]**

Module VI: Atom field interaction, density matrix equation, closed and open two level atoms, Rabi oscillations. **[6]**

Module VII: Relativistic wave equations: 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, positive and negative energy states, significance of negative energy states. **[8]**

Book:

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

References:

1. Quantum Mechanics by L. D. Landau and E. M. Lifshitz (Pergamon, Berlin)

3. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (McMillan India)

4. A Textbook of Quantum Mechanics by P. T. Mathews (Tata McGraw Hill)

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2013 Laser Physics and Applications

[3-0-0-3]

Module I & II: Properties of laser, 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, laser line shape, hole burning, Lamb dip, output power. [12]

Module III: Theory of resonator, ABCD matrix, Stable and unstable resonator, longitudinal and transverse mode of the cavity. [6]

Module IV: Continuous wave, Pulsed, Q- switched and Mode locked lasers. [6]

Module V: Different type of lasers, design (in brief) and functioning of different lasers - Ruby laser, Nd: YAG laser, He-Ne laser, CO₂ laser, Argon ion laser, Dye laser, Excimer laser. Free electron laser. [8]

Module VI & VII: Measurement with laser, alignment, targeting, tracking, velocity measurement, surface quality measurement, Measurement of distance (interferometric, pulse echo, Beam modulation), laser gyroscope, Holographic non destructive testing (NDT). Application in communication. Material Processing: cutting, welding, drilling and surface treatment. Medical Applications. [8]

Book:

1. O. Svelto; Principles of Lasers, Springer (2004)
2. Laser Fundamentals: William T. Silfvast, Cambridge University Press (1998)
3. K. Shimoda, Introduction to laser Physics, Springer Verlag, Berlin (1984)
4. Laser Electronics: J.T.Verdeyen, 3rd Ed, Prentice Hall (1994)
5. Laser Applications in Surface Science and Technology; H.G.Rubahn; John Wiley & Sons (1999)
6. Optical Methods in Engineering Metrology: Ed D.C.Williams; Chapman & Hall

SAP 2002 Physics Laboratory -II (Lasers and Advanced Optics)

[0-0-3-2]

SAP 2004 Physics Laboratory-III- Electronics and Instrumentation Laboratory

[0-0-3-2]

I.M.Sc Physics-IX-Semester/M.Sc Physics -III Semester

SAP 3301 Nuclear and Particle Physics

[3-0-0-3]

Module I: Nuclear Models

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 , collective model.

Module II: Two nucleon problem

The Deuteron, ground state of deuteron, nature of nuclear forces, excited state of deuteron, spin-dependence of nuclear force, meson theory of nuclear force

Module III: Scattering

Cross-section, differential cross-section, scattering cross-section, nucleon-nucleon scattering, proton-proton and neutron-neutron 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 electrons, absorption of gamma rays, photoelectric effect, Compton effect and pair production

Module V: Elementary particles I

Mesons, leptons, baryons, antiparticles, neutrinos, antineutrino and strange particles

Module VI: Elementary particles II

Eightfold way, Baryon octet and meson octet, Quark model, Baryon Decuplet, meson nonlet, Intermediate vector boson, strong, electromagnetic and weak interactions, standard Model, lepton classification and quark classification.

Books Recommended:

1. Nuclear Theory- Roy and Nigam
2. Introductory Nuclear Physics- Kenneth S. Krane
3. Nuclear Physics : D. Halliday
4. Elements of Nuclear Physics :Pandya and Yadav
4. Introduction to Elementary Particles: David Griffiths

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3007 Advanced Electrodynamics

[3-0-0-3]

Module 1 & 2: Waveguides, Resonant Cavities, and Optical Fibers

Transmission line parameters-transmission line equations-input impedance, SWR and power-the Smith chart-some application of transmission lines. Cylindrical Cavities and Waveguides, Waveguides, TE and TM modes in a Rectangular Waveguide, Energy Flow and Attenuation in Waveguides, Perturbation of Boundary Conditions, Resonant Cavities, Power Losses in a Cavity; Q of a Cavity, Earth and Ionosphere as a Resonant Cavity: Schumann Resonances. [10]

Module 3: Radiating Systems, Multipole Fields and Radiation

[6]

Fields and Radiation of a Localized Oscillating Source, Multipole Expansion for Localized Source, Spherical Wave Solutions of the Scalar Wave Equation, Multipole Expansion of the Electromagnetic Fields, Angular Distribution of Multipole Radiation

Module 4: Special Theory of Relativity

[6]

Matrix representation of Lorentz transformations, infinitesimal generators, Thomas precession, invariance of electric charge; covariance of electrodynamics, transformation of electromagnetic fields, relativistic equation of motion for spin in uniform or slowly varying external fields

Module 5: Dynamics of Relativistic Particles and Electromagnetic Fields

[6]

Lagrangian and Hamiltonian for a Relativistic Charged Particle in External Electromagnetic Fields
Motion in a Uniform, Static Magnetic Field, Motion in Combined, Uniform, Static Electric and Magnetic Fields, Particle Drifts in Nonuniform, Static Magnetic Fields,

Module 6: Collisions and Energy Loss

[6]

Energy transfer in Coulomb collision between heavy incident particle and free electron; energy loss in hard and soft Collisions; Total Energy Loss Cherenkov Radiation

Module 7: Bremsstrahlung, Method of Virtual Quanta

[6]

Radiation Emitted During Collisions, Bremsstrahlung in Coulomb Collisions, Screening Effects; Relativistic Radiative Energy Loss, Weizsacker-Williams Method of Virtual Quanta, Bremsstrahlung as the Scattering of Virtual Quanta

Textbook and References:

1. Electromagnetic Theory - Stratton
2. Electromagnetic Theory – J. A. Kong; John Wiley and Sons, 1986
3. Classical Electricity and Magnetism – Phillips and Panofsky, Addison Wesley
4. Introduction to Electrodynamics – D. J. Griffiths; John Wiley and Sons, 1986
5. Engineering Electromagnetics - William H. Hayt
6. Elements of engineering electromagnetics - Narayana Rao, PHI
7. Electromagnetic Waves and Radiating Systems – E. C. Jordan and K. G. Balmain, Prentice Hall, Inc.

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3115: Advanced Experimental Techniques

[3-0-0-3]

Module I: X-ray Diffraction Methods:

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. [5]

Module II: Microscopy

Optical microscopy, metallurgical microscope, TEM, SEM and AFM, specimen preparation, instrumentation and applications, Low Energy electron Spectroscopy. [5]

Module III: Spectroscopy

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. [8]

Module IV: ESR and Mossbauer spectroscopy

Basic principles of ESR, Instrumentations and applications, Principle of Mossbauer spectroscopy, Isomer shift, Quadruple splitting and hyperfine interaction, applications-in determination of phases and diffusion studies. [7]

Module V: Thermochemical analysis

Thermo analytical techniques, Instrumentation and applications of TGA, DTA, DSC. [5]

Module VI: Electrochemical Techniques

Electrochemical Instrumentation, Coulometry, polarography, cyclic voltametry, application to oxidation-reduction reaction, Principle of Corrosion, types and prevention. [10]

Module VII: Vacuum Technology & Thin film Deposition Technique

Application to Vacuum Technology, Types of vacuum pumps, different technique of thin film deposition CVD, PVD, MBE, MOCVD. [10]

References:

- 1.. Surface Analysis – The Principal Techniques, Ed ited by J. C. Vickerman, John Willey & Sons
2. Spectroscopy, Vol. I, II and III, ed. By Straughan and Walker, John Wiley.
3. Instrumental Methods of Chemical Analysis By G. W. Ewing, Mcgraw –Hill Book Company
4. Vacuum Science and Technology by V.V. Rao, T.B. Gosh, K.L. Chopra, Allied Publishers, 17-Oct-1998

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

**SAP 3002 Physics Laboratory IV Advanced Materials Science laboratory
[0-0-3-2]**

**SAP 3104 Physics Laboratory V
[0-0-3-2]**

SAP 3009 Plasma Physics

[3-1-0-4]

Module I:

Introduction and brief history of plasma physics, concept of temperature, Energy distribution function, 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 II:

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 III:

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 IV:

Basic plasma diagnostics: electric probes (single and double), optical emission spectroscopy (basic idea)

Module V:

Plasma Applications: MHD energy generator, Controlled thermo-nuclear fusion, Tokamaks, Space & Astrophysical plasmas.

Module VI:

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 VII:

Industrial applications of plasma: 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. Fran k-Kamenetskii, Macmillan Press, 1972

Module I: One electron Approximation; Introduction, The free electron without interactions, The energy states, excited states, the Fermi distribution, free electron in electric field, free electron in magnetic field, Dia and para magnetism of free electrons. The basic Hamiltonian, The Schrodinger equation for electrons in a periodic potential.

Module II: Elementary Excitation: Electron- Electron interaction, Coulomb Interaction, the Hartree and Hartree-Fock approximation. Electron-Hole interactions in semiconductors and insulators. Ion-Ion Interaction (Phonons), Spin-Spin interactions (magnons).

Module III: Transport Phenomena: Electron-Electron interaction; Interaction of electrons with Acoustic Phonon, Electron-Phonon Interaction in Polar solids (polarons), transport in metal and semiconductors.

Module IV: Superconductivity: Electron- Electron interaction by exchange of virtual phonons, Cooper pairs, BCS theory, Ginzburg-Landau theory, flux quantization.

Module V: Optical phenomena: Electron-Photon Interaction, Phonon-Photon interaction, Raman and Brillouin scattering

Module VI: Thermal properties: Phonon-Phonon interaction, Frequency shift, lifetime of phonon, Thermal conductivity of the lattice.

Module VII: Localized states: Shallow impurity states in semiconductor, Localised lattice vibrational states in solids, Electron-phonon interaction at imperfections, imperfection as scattering centres, the Kondo effect.

References:

O Madelung- Introduction to solid state theory

Callaway- Quantum theory of solids

C Kittel-Quantum theory of solids

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3013: Microwave Electronics

[3-1-0-4]

Module 1: Transmission lines and Waveguides (12 Classes) Introduction of Microwaves and their applications. Types of Transmission lines, Characterization in terms of primary and secondary constants, Characteristic impedance, General wave equation, Loss less propagation, Propagation constant, Wave reflection at discontinuities, Voltage standing wave ratio, Transmission line of finite length, The Smith Chart, Smith Chart calculations for lossy lines, Impedance matching by Quarter wave transformer, Single and double stub matching. Rectangular Waveguides: TE and TM wave solutions, Field patterns, Wave impedance and Power flow.

Module 2: Microwave Sources (7 Classes) Microwave Linear-Beam (O type) and Crossed-Field tubes (M type), Limitations of conventional tubes at microwave frequencies, Klystron, Multicavity Klystron Amplifiers, Reflex Klystrons, Helix Travelling-wave tubes, magnetron Oscillators. Tunnel diode, TED - Gunn diode, Avalanche transit time devices IMPATT (also TRAPAT) and parametric devices,

Module 3: Stripline and microstrip lines (6 Classes) Dominant mode of propagation, Field patterns, Characteristic impedance, Basic design formulas and characteristics. Parallel coupled striplines and microstrip lines- Even- and odd- mode excitations. Slot lines and Coplanar lines. Advantages over waveguides

Module 4: Microwave Network Analysis (5 Classes) Impedance and Admittance matrices, Scattering matrix, Parameters of reciprocal and Loss less networks, ABCD Matrix, Scattering matrices of typical two-port, three-port and four-port networks, Conversion between two-port network matrices.

Module 5: Microwave Passive Components (8 Classes) Waveguide Components: E-plane and H-plane Tees, Magic Tee, Shorting plunger, Directional couplers, and Attenuator. Stripline and Microstrip line Components: Open and shorted ends. Half wave resonator, Lumped elements (inductors, capacitors and resistors) in microstrip. Ring resonator, 3-dB branchline coupler, backward wave coupler, Wilkinson power dividers and rat-race hybrid ring. Low pass and band pass filters.

Module 6: Microwave Measurements (6 Classes) Detection of microwaves, Microwave power measurement, Impedance measurement, Measurement of reflection loss (VSWR), and transmission loss in components. Passive and active circuit measurement & characterization using network analyser, spectrum analyser and noise figuremeter

Module 7: Microwave Integrated Circuit Technology (6 Classes) Substrates for Microwave Integrated Circuits (MICs) and their properties. Hybrid technology – Photolithographic process, deposited and discrete lumped components. Microwave Monolithic Integrated Circuit (MMIC) technology- Substrates, MMIC process, comparison with hybrid integrated circuit technology (MIC technology).

RECOMMENDED BOOKS:

1. Electromagnetic Waves and Radiating Systems – E.C. Jordan & K.G. Balmain, Prentice Hall, Inc.
2. Microwave Devices and Circuits - S. Y. LIAO, PHI
3. Introduction to Microwave Theory and Measurements – L. A. Lance, TMH
4. Transmission lines and Networks – Walter C. Johnson , McGraw Hill, New Delhi
5. Networks Lines and Fields – John D. Ryder
6. Microwave Engineering: Passive Circuits - Peter A. Razi, Prentice Hall of India Pvt. Ltd, New Delhi.
7. Waveguides – H.R.L. Lamont, Methuen and Company Lim ited, London
8. Foundations for Microwave Engineering – Robert E. C ollin, McGraw Hill Book Company, New Delhi
9. Microwave Engineering – Annapurna Das, TMH, New Del hi

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP. 3017 Fiber and Integrated Optics

[3-1-0-4]

Module I: Principle of light propagation in fibers, step-index and graded index fibers; single mode, multimode and W-profile fibers. Ray optics representation, meridional and skew rays. Numerical aperture and acceptance angle. Dispersion, combined effects of material and other dispersions - RMS pulse widths and frequency response, birefringence. Attenuation in optical fibers. [12]

Module II: Wave propagation in step-index fibers, modes in an ideal step-index fiber - weakly guiding solutions. Material dispersion and waveguide dispersion in single-mode fibers. [6]

Module III: Wave propagation in graded-index fibers, modes in graded index fibers, approximate solutions and number of modes. Equivalence of WKB approximation and ray model. Inter and intramodal dispersion in graded-index fibers. Mode coupling. [6]

Module IV&V: Theory of optical waveguides, planar, rectangular, symmetric and asymmetric waveguides, channel and strip loaded waveguides. Anisotropic and segmented waveguides. Step-index and graded index waveguides, guided and radiation modes. Arrayed waveguide devices. Fabrication of integrated optical waveguides and devices. [12]

Module VI: Wave guide couplers, transverse couplers, grating couplers, tapered couplers, prism couplers, fiber to waveguide couplers. Multilayer planar waveguide couplers, dual channel directional couplers, Butt coupled ridge waveguides, Branching waveguide couplers. Directional couplers, optical switch; phase and amplitude modulators, filters, etc. Y-junction, power splitters. [6]

Module VII: Fiber optics sensors, intensity modulation, phase modulation sensors, fiber Bragg grating sensors. Measurement of current, pressure, strain, temperature, refractive index, liquid level etc. Time domain and frequency domain dispersion measurement. [8]

References:

1. Introduction to Fiber Optics: A.K. Ghatak and K. Thyagarajan, Cambridge University press.
2. Integrated Optics: Theory and Technology; R. G. Hunsperger; Springer (2002)
3. Optical Fiber Sensors, John Dakin and Brian Culshaw, Arctech House Inc.
4. Essentials of optoelectronics, Alan Rogers, 1st Ed., Chapman & Hall.
5. Semiconductor Optoelectronics Devices, P. Bhattacharya, PHI.
6. Optoelectronics and Photonics, principles and practices S. O. Kasap, Prentice Hall

Module I: Introduction to Plasma

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

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

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

Langmuir oscillations, ion waves, electromagnetic waves along and perpendicular to B_0 , Alfvén waves.

Module V: Plasma production

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

Langmuir probe, Spectroscopic diagnostics.

Module VII: Plasma Applications

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

Module-I : Fundamentals of Plasma Physics and Plasma Chemistry

Plasma-the fourth state of matter, Plasma Parameters, Debye length, Plasma oscillations & frequency, Plasma Sheath, Interaction of electromagnetic wave with plasma, Concept about plasma equilibrium, Industrial Plasmas, Cold and thermal plasma, Plasma Chemistry, Homogeneous and Heterogeneous reaction, Reaction rate coefficients, Plasma Surface interaction

Module-II: Plasma dynamics and Fluid mechanics of plasmas

Fluid mechanics of plasmas, Concepts of MHD equations

Module-III: Plasma models and Radiation transport

Concepts about Local Thermal Equilibrium (LTE), PLTE, Corona and CR models of plasma

Module-IV: Plasma Production Techniques

DC discharges, Glow discharge, Normal and abnormal glow discharges, Arc discharge, Arc stabilization, Transferred and non transferred arcs Cathode and anode fall, Arc Column, RF discharge, Capacitively and inductively coupled plasmas, Microwave discharge, ECR Plasmas

Module-V: Plasma Diagnostic Techniques

Measurements of Plasma parameters, Electrical probes, Single and double Langmuir probe, Magnetic probe, Calorimetric measurements, Enthalpy Probes, Spectroscopic method

Module-VI: Applications

Plasma treatment of textiles, Underwater cutting by plasma torches, Ion implantation, Re- entry plasma simulation and aerospace material testing, Plasma propulsion, devices, Plasma as light source, Flat panel displays

REFERENCES:

1. Principles of plasma discharges and materials processing, M. A. Lieberman and A. J. Lichtenberg, (John Wiley and Sons, 2005)
2. Plasma Physics and Engineering, A. Friedman and L. A. Kennedy, (Taylor and Francis, New York, 2004)
3. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
4. Thermal Plasmas- Fundamentals and Applications, M. I. Boulos, P. Fauchais and E. Pfender, (Plenum Press, New York and London, 1994)
5. Plasma Technology, B. Gross, B. Greyz and K. Miklossy, (Iliffe Books Ltd., London, 1968).
6. Industrial plasma engineering: Vol. 1 & 2, J. R. Roth, (IOP, 1995 & 2001)
7. Handbook of Plasma Processing Technology: Fundamental, Etching, Deposition and Surface Interactions, S. M. Rosnagel, J. J. Cuomo, W. D. Westwood, (Noyes Publications, 1990)

Module-I: Plasma statistics and Thermodynamics

Plasmas and thermodynamic equilibrium, Thermodynamics of ideal gases, Dissociation and ionization equilibrium in Gas mixtures, Statistics and thermodynamics of equilibrium and non-equilibrium plasma, Determination of plasma composition, Thermodynamic and transport properties of plasma

Module-II: Design principles of plasma reactors

Design principles and construction of plasma torches and thermal plasma reactors, Efficiency of plasma torches in converting electrical energy in to thermal energy, Designing aspects of low pressure plasma reactors

Module-III: Plasma Production Techniques

Coronal discharges. Photo plasmas, Shock wave generated plasma, Atmospheric pressure glow discharges, Dielectric barrier discharges

Module-IV: Plasma Diagnostic Techniques

Laser based diagnostics, Microwave and Laser interferometer, Laser induced fluorescence, Thomson scattering, Absorption spectroscopy

Module-V: Plasma Etching and Spraying

Anisotropic etching, plasma cleaning, surfactants removal, plasma ashing, plasma Polymerization, Non transferred plasma torches, powder feeder, optimization of spraying processes, spherodization.

Module-VI: Plasma sputtering and PECVD

Thin film coatings, magnetron sputtering, RF PECVD, MW PECVD, plasma nitriding

Module-VII: Atmospheric Plasma Processing

Arc plasmas, Plasma torches, plasma waste processing, Synthesis of materials and metallurgy in arc plasmas, Plasma cutting and Welding

REFERENCES:

1. Principles of plasma discharges and materials processing, M. A. Lieberman and A. J. Lichtenberg, (John Wiley and Sons, 2005)
2. Plasma Physics and Engineering, A. Friedman and L. A. Kennedy, (Taylor and Francis, New York, 2004)
3. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
4. Thermal Plasmas- Fundamentals and Applications, M. I. Boulos, P. Fauchais and E. Pfender, (Plenum Press, New York and London, 1994)
5. Plasma Technology, B. Gross, B. Greyz and K. Miklossy, (Ilfie Books Ltd., London, 1968).
6. Industrial plasma engineering: Vol. 1 & 2, J. R. Roth, (IOP, 1995 & 2001)
7. Handbook of Advanced Plasma Processing Techniques, Eds. R.J. Shul and S.J. Pearton,

SAP 4007 Thin Film and Vacuum Technology

[3-1-0--4]

Module-I

Thermodynamics and Thin Film growth

Module-II

Vacuum Technology: Gas Laws, Kinetic Theory of Gases, Conductance and Throughput, Gas Sources in a Vacuum Chamber, Vacuum Pumps.

Module-III

Physical Vapor Deposition: Sputtering (Plasma Physics (DC Diode), rf Plasmas, Magnetic Fields in Plasmas, Sputtering Mechanisms), Evaporation.

Module-IV

Chemical Vapor Deposition: Mechanisms, Materials, Chemistries, Systems.

Module-V

Etching: Wet Chemical Etching (Mechanisms, Materials and Chemistries), Dry Plasma Etching/Reactive Ion Etching (Mechanisms, Materials and Chemistries).

Module-VI

FILM Formation and Structure: Capillarity Theory, Atomistic Nucleation processes, Cluster Coalescence, Grain Structure of Films.

Module-VII

Thin Film Characterization: Structural, Chemical

Textbook:

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

References:

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

SAP 4009 Physics of Solid State Devices

[3-1-0-4]

Module I:

Carrier transport phenomena in solids: carrier drift and diffusion process, transport in crystalline and amorphous semiconductors, high field properties of semiconductors, organic semiconductors.

Module II:

p-n junction devices: Minority and majority carrier injection, Depletion layer, I-V characteristics, heterojunctions and superlattices, Metal-semiconductor junctions, Schottky and Ohmic contacts.

Module III:

Three terminal devices: bipolar junction transistor (BJT), junction field effect transistor (JFET), metal oxide field effect transistor (MOSFET) metal semiconductor field effect transistor (MESFET).

Module IV & V:

Integrated circuits: Introduction of analog IC's, digital IC's, Monolithic IC's, Hybrid IC's. Materials for IC fabrication (Si and GaAs), Crystal growth and wafer preparation, Epitaxy, Vapour phase epitaxy (VPE), Molecular beam epitaxy (MBE), MOCVD Oxidation, diffusion, Ion implantation, Optical lithography, electron beam lithography, etching processes.

Module VI:

Single electron devices: Energy states of jailed electron, Quantum point contact, Coulomb blockade, Resonant tunneling transistor, Single electron transistor (SET).

Module VII:

Microwave semiconductor devices: Tunnel diode, IMPATT, Gunn effect and Gunn diode.

Text Books:

1. Streetman, B.G. and Banerjee, S., Solid State Electronic Devices, 6th Edition, (Prentice-Hall, 2005).
2. Grove, A.S., Physics and Technology of Semiconductor Devices, (John Wiley, 1971).

Reference Book(s)

1. Sze, S.M. and Kwok, K.Ng., Physics of Semiconductor Devices, 3rd Edition, (Wiley-Interscience, 2006).
2. Quinn, J.J. and Yi, K-S., Solid State Physics: Principles and Modern Applications, 1st Edition (Springer, 2009).

Modules I, II & III

Metals, Alloys, Ceramics, Polymers and Composites: Phase rules Fe-C phase diagram, steels, cold, hot working of metals, recovery, recrystallization and grain growth, Structure, properties, processing and applications of ceramics. Classification of polymers, polymerization, structure, properties, additives, products, processing and applications. Quasicrystals, Conducting Polymers; Properties and applications composites. [18]

Modules IV and V

Advanced Materials: Smart materials, ferroelectric, piezoelectric, biomaterials (some basic information), superalloys, aerospace materials, shape memory alloys, optoelectronic materials, Materials for photodiode, light emitting diode (LED), Photovoltaic/Solar cell. [16]

Modules VI and VII:

Nanostructured Materials: Nanomaterials classification (Gleiter's Classification)–properly changes done to size effects, synthesis of nanomaterials, ball milling, Liquid state processing - Sol-gel process, Vapour state processing –CVD, MBE, Aerosol processing, Quantum dot, wire and well, fullerene and tubules, formation and characterization of fullerenes and tubules, single wall and multiwall carbon tubules, electronic properties of tubules, applications: optical lithography, MOCVD, super hard coating. [16]

Text books:

1. Materials Science and Engineering, An Introduction, 5th Edition, William D. Callister Jr., John Wiley & Sons, Inc., New York, 1999, with CD-ROM.
2. Principles of Materials Science and Engineering, W. F. Smith, McGraw Hill International, 1986. (WFS)
3. Introduction to nanotechnology, Charles P. Poole, Jr. and Frank J. Owens; Wiley student edition (reprint-2009).

Reference books:

1. Structure and properties of engineering materials, fifth edition, Henkel and Pense, McGraw Hill, 2002
2. Biomaterials Science, An Introduction to Materials in Medicine , Edited by B.D. Ratner, A.S. Hoffman, F.J. Sckoen, and J.E.L Emons, Academic Press, second edition, 2004

SAP 4013 Nonconventional Energy Materials

[3-1-0-4]

Module 1: Current Status of Energy Sources: Energy sources and their availability, conventional sources of energy: Fossil fuel, Hydraulic energy, Nuclear energy: nuclear fission, nuclear fusion, Environmental impact of conventional sources of energy, Need for sustainable energy sources, Non-conventional energy sources, Current status of renewable energy sources. [6]

Module 2: P-N Junction Solar Cells: P-N Junction: space charge region, energy band diagram, carrier movements and current densities, carrier concentration profile; P-N junction in non-equilibrium condition, I-V Relation, P-N Junction under Illumination, Generation of photovoltage, Light generated current, I-V equation of solar cells. [6]

Module 3: Design of Solar Cells and its characterization : Solar Cell Characteristics and Cell parameters: Short circuit current, open circuit voltage, fill factor, efficiency; losses in solar cells, Solar Cell Design: design for high I_{sc} , design for high V_{oc} , design for high FF; Solar spectrum at the Earth's surface, Solar simulator: I-V Measurement, quantum efficiency (QE) Measurement, minority carrier lifetime and diffusion length measurement. [7]

Module 4: Wafer-Based Solar Cell Technology: Development of Si solar cells, Processes of solar cell fabrication: saw damage removal and surface texturing, P-N Junction formation, ARC and surface passivation, metal contacts—pattern defining and de position. Thin Film Solar Cell Technologies: Advantages of thin film technologies, materials for thin film technologies, thin film deposition techniques, thin films solar cell structures, thin film crystalline, microcrystalline, polycrystalline, and amorphous Si solar cells. [10]

Module 5: Emerging Solar Cell Technologies

Organic Solar Cells: working principle, material properties, solar cell structure; Dye-sensitized Solar Cell (DSC): working principle, materials and their Properties; GaAs solar cells, Thermo-photovoltaics, multijunction solar cells. [7]

Module 6: Nonconventional Energy Sources: Wind Energy: Classification of wind mills, advantages and disadvantage of wind energy; Bio Energy: Bio gas and its compositions, process of bio gas, generation – wet process, dry process, utilization and benefits of biogas technology. [7]

Module 7: Other Nonconventional Energy Sources: Tidal Power: Introduction, classification of tidal power plants, factors affecting the suitability of the site for tidal power plant, advantages and disadvantages of tidal power plants. Fuel Cells: Introduction, working of fuel cell, types of fuel cells, advantages of fuel cell technology. Solar Thermal: Solar collectors, solar cookers, solar water heater. [7]

Text/Reference Books:

1. Solar cells: Operating principles, technology and system applications by Martin A Green, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Semiconductor for solar cells, H J Moller, Artech House Inc, MA, USA, 1993.
3. Solis state electronic device, Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.
4. Direct energy conversion, M.A. Kettani, Addison Wesley Reading, 1970.
5. Hand book of Batteries and fuel cells, Linden, Mc Graw Hill, 1984.

SAP 4015 Physics of Thin Films

[3-1-0-4]

Module 1: Basic Thermodynamics of Thin Films

[8]

Solid surface, interphase surface, Surface energies: Binding energy and Interatomic Potential energy, latent heat, surface tension, Liquid surface energy measurement by capillary effect, by zero creep; magnitude of surface energy, General concept, jump frequency and diffusion flux, Fick's First law, Non - linear diffusion, Fick's second law, calculation of diffusion coefficient, interdiffusion and diffusion in thin films,

Module 2: Vacuum Science & Technology:

[6]

Kinetic theory of gases, gas transport and pumping, Conductance, vacuum pumps and measurement gauges.

Module 3: Mechanisms of Film Formation

[8]

Stages of thin film formation: Nucleation, Adsorption, Surface diffusion, capillarity theory of nucleation, statistical theory of nucleation, growth and coalescence of islands, grain structure and microstructure of thin films, diffusion during film growth, polycrystalline and amorphous films.

Module 4 & 5: Methods of Preparation of Thin Films:

[15]

Physical vapour deposition: Vacuum evaporation-Hertz- Knudsen equation, evaporation from a source and film thickness uniformity, Glow discharge and plasmas-Plasma structure, DC, RF and microwave excitation; Sputtering processes-Mechanism and sputtering yield, Sputtering of alloys; magnetron sputtering, Reactive sputtering; vacuum arc: cathodic and anodic vacuum arc deposition.

Chemical vapour deposition: Thermodynamics of CVD, gas transport, growth kinetics, Plasma chemistry, plasma etching mechanisms; etch rate and selectivity, orientation dependent etching; PECVD

Module 6: Epitaxy:

[7]

Epitaxy: Structural aspects of epitaxy, homo- and hetero-epitaxy, lattice misfit and imperfections; epitaxy of compound semiconductor, theories of epitaxy, Role of interfacial layer, Artificial semiconductors, Band-gap engineering, Super lattice structures, Epitaxial film growth and characterization

Module 7: Characterization of thin films:

[6]

Deposition rate, Film thickness and uniformity, Structural properties: Crystallographic properties, defects, residual stresses, adhesion, hardness, ductility, electrical properties, magnetic properties; optical properties.

Text books:

1. The Material Science of Thin Films by Milton Ohring, Academic Press, Inc., 1992.
2. Handbook of Thin Films by Maissel and Glang
3. Thin Film Phenomena by K. L. Chopra

Reference books:

1. Coating Technology Handbook by D. Satas, A. A. Tracton, Marcel Dekkar Inc. USA.
2. Arc Plasma Technology in Material Science, P. A. Gerdeman and N. L. Hecht, Springer Verlag, 1972.

SAP 4019: Microprocessors and Microcontrollers

[3-1-0-4]

Module 1 [9]

8086 Architecture; Introduction to 8085 Microprocessor, 8086 Architecture-Functional diagram. Register Organization, Memory Segmentation. Programming Mode!. Memory addresses. Physical memory organization. Architecture of 8086, signal descriptions of 8086- common function signals. Minimum and Maximum mode signals. Timing diagrams. Interrupts of 8086.

Module 2

[7]

Instruction Set and Assembly Language Programming of 8086: Instruction formats, addressing modes, instruction set, assembler directives, macros, simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations.

Module 3

[8]

I/O Interface: 8255 PPI various modes of operation and interfacing to 8086. Interfacing keyboard, display, stepper motor interfacing, D/A and A/D converter. Memory interfacing to 8086, Interrupt structure of 8086, Vector interrupt table, Interrupt service routine, Introduction to DOS and BIOS interrupts, Interfacing Interrupt Controller 8259 DMA Controller 8257 to 8086.

Module 4

[6]

Communication Interface: Serial communication standards, Serial data transfer schemes. 8251 USART architecture and interfacing, RS-232, IEEE-4-88, Prototyping and trouble shooting

Module 5

[6]

Introduction to Microcontrollers: Overview of 8051 microcontroller. Architecture. I/O Ports. Memory organization, addressing modes and instruction set of 8051, simple program

Module 6

[7]

8051 Real Time Control: Interrupts, timer/ Counter and serial communication, programming Timer Interrupts, programming external hardware interrupts, programming the serial communication interrupts, programming 8051 timers and counters.

Module 7

[7]

The AVR RISC microcontroller architecture: Introduction, AVR Family architecture, Register File, The ALU. Memory access and Instruction execution. I/O memory. EEPROM. I/O ports. Timers. UART. Interrupt Structure

TEXT BOOKS:

1. D. V. Hall. Micro processors and Interfacing, TMGH. 2nd edition 2006.
2. Kenneth. J. Ayala. The 8051 microcontroller , 3rd edition, Cengage learning, 2010

REFERENCE BOOKS:

1. Advanced Microprocessors and Peripherals - A. K. Ray and K.M. Bhurchandani, TMH, 2nd edition 2006.
2. The 8051 Microcontrollers, Architecture and programming and Applications -K.Uma Rao, Andhe Pallavi,,Pearson, 2009.
3. Micro Computer System 8086/8088 Family Architecture. Programming and Design - By Liu and GA Gibson, PHI, 2nd Ed.,
4. Microcontrollers and application, Ajay. V. Deshmukh, TMGH. 2005

SAP 4021: Instrumentation and Control

[3-1-0-4]

Module 1 and 2: Sensors

(15)

Measurement basics: range, resolution, linearity, hysteresis, reproducibility and drift, calibration, accuracy and precision. Sensor Systems, characteristics, Instrument Selection, Measurement Issues and Criteria, Acceleration, Shock and Vibration Sensors, Interfacing and Designs, Capacitive and Inductive Displacement Sensors, Magnetic Field Sensors, Flow and Level Sensors, Load Sensors, Strain gauges, Humidity Sensors, Accelerometers, Photosensors, Thermal Infrared Detectors, Contact and Non-contact Position sensors, Motion Sensors, Piezoresistive and Piezoelectric Pressure Sensors, Sensors for Mechanical Shock, Temperature Sensors (contact and non-contact)

Module 3 & 4: Signal conditioning

(15)

Types of signal conditioning, Amplification, Isolation, Filtering, Linearization, Classes of signal conditioning, Sensor Signal Conditioning, Conditioning Bridge Circuits, D/A and A/D converters for signal conditioning, Signal Conditioning for high impedance sensors

Grounded and floating signal sources, single-ended and differential measurement, measuring grounded signal sources, ground loops, signal circuit isolation, measuring ungrounded signal sources, system isolation techniques, errors, noise and interference in measurements, types of noise, noise minimization techniques

Module 5: Actuators

(4)

Correction and regulating elements used in control systems, pneumatic, hydraulic and electric correction elements.

Module 6 & 7: Control System

(16)

Open loop and closed loop (feedback) systems and stability analysis of these systems, Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of linear time invariant (LTI) control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral- Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

References:

1. Electronic Instrumentation - H. S. Kalsi, Tata McGraw-Hill Education, 2010
2. Electronic Instrumentation - W. Bolton
3. Instrumentation: Electrical and Electronic Measurements and Instrumentation - A. K. Sawhney,
4. Modern Electronic Instrumentation & Measurement Techniques - Helfrick & Cooper

SAP 4023: Integrated Electronics

[3-1-0-4]

Logic Families

(5 Classes)

Diode Transistor Logic, High Threshold Logic, Transistor-transistor Logic, Resistor-transistor Logic, Direct Coupled Transistor Logic, Comparison of Logic families

Integrated Chip Technology

(20 Classes)

Overview of semiconductor industry, Stages of Manufacturing, Process and product trends, Crystal growth, Basic wafer fabrication operations, process yields, semiconductor material preparation, yield measurement, contamination sources, clean room construction, substrates, diffusion, oxidation and photolithography, doping and depositions, implantation, rapid thermal processing, metallization. patterning process, Photoresists, physical properties of photoresists, Storage and control of photoresists, photo masking process, Hard bake, develop inspect, Dry etching Wet etching, resist stripping, Doping and depositions: Diffusion process steps, deposition, Drive-in oxidation, Ion implantation, CVD basics, CVD process steps, Low pressure CVD systems, Plasma enhanced CVD systems, Vapour phase epitaxy, molecular beam epitaxy. Design rules and Scaling, BICMOS ICs: Choice of transistor types, pnp transistors, Resistors, capacitors, Packaging: Chip characteristics, package functions, package operations

Nanoelectronic devices

(25 Classes)

Effect of shrinking the p-n junction and bipolar transistor; field-effect transistors, MOSFETs, Introduction, CMOS scaling, the nanoscale MOSFET, vertical MOSFETs, electrical characteristics of sub-100 nm MOS transistors, limits to scaling, system integration limits (interconnect issues etc.), heterostructure and heterojunction devices, ballistic transport and high-electron-mobility devices, HEMT, Carbon Nanotube Transistor, single electron effects, Coulomb blockade. Single Electron Transistor, Resonant Tunneling Diode, Resonant Tunneling Transistor, applications in high frequency and digital electronic circuits and comparison with competitive devices, direct and indirect band gap semiconductors, QWLED, QW Laser, Quantum Cascade Laser

Integrated Micromachining Technologies for Transducer Fabrication, Applications of Functional Thin Films and Nanostructures in Gas Sensing, Chemical Sensors, Applications of Functional Thin Films for Mechanical sensing, Sensing Infrared signals by Functional Films

Textbooks and Reference Books:

1. Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, McGraw-Hill, 1977
2. S.M. Sze, Ed, Modern Semiconductor Device Physics, Wiley, New York
3. S.M. Sze and K.K. Ng, Physics of Semiconductor Devices, 3rd Ed, Wiley, Hoboken.
4. S. Wolf and R.N. Tauber, Silicon Processing, vol. 1, (Lattice Press)
5. S. Wolf and R. N. Tauber, Silicon Processing for the VLSI Era. (Lattice Press, 2000)
6. Streetman, B.G. Solid State Electronic Devices, Prentice Hall, Fifth Edition, 2000
7. R. D. Doering and Y. Nishi, Handbook of Semiconductor Manufacturing Technology, CRC Press, Boca Raton.
8. W. R. Fahrner (Editor), Nanotechnology and Nanoelectronics, Materials, Devices, Measurement Techniques
9. Anis Zribi, Jeffrey Fortin (Editors), Functional Thin Films and Nanostructures for Sensors Synthesis, Physics, and Applications

SAP 4027 Quantum and Nonlinear Optics

[3-1-0-4]

Module I & II: Nonlinear Optical Phenomena: Introduction to nonlinear optics, description of nonlinear optical interaction, phenomenological theory of nonlinearity, nonlinear optical susceptibilities. Sum and difference frequency generation, second harmonic generation, coupled wave equation. Manley-Rowe relations, phase matching of SHG, quasi phasematching, electric field induced SHG (EIFISH), optical parametric amplification, third harmonic generation, two-photon absorption. Stimulated Raman scattering and stimulated Brillouin scattering. [12]

Module III: Two level atoms: 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. [10]

Module IV: Intensity dependent phenomena: intensity dependent refractive index, self-focusing, self phase modulation, spectral broadening, optical continuum generation by short optical pulse. Optical phase conjugation, application of OPC in signal processing. Self induced transparency, spatial and temporal solitons, solitons in Kerr media, photorefractive and quadratic solitons, optical vortices. Pulse compression. [10]

Module V: Bistability: optical bistability, Steady state bistability, absorptive bistability, Dispersive bistability, Optical switching. [6]

Module VI: Ultra fast Phenomena: ultrafast pulse generation with and without mode locking, range gating with Ultra short pulse, four dimensional imaging. femto second laser Gyroscope, Soliton pulses. Transient NLO effects, Bloch vectors, Rabi oscillations, photon echo, self induced transparency, optical nutation, free induction decay. [6]

Module VII: Nonlinear guided wave optical devices: nonlinear planar waveguide, nonlinear channel waveguide, nonlinear directional coupler, nonlinear mode sorter, nonlinear Mach-Zehnder interferometer and logic gate, Nonlinear loop mirror. [6]

Book:

1. Fundamentals of Nonlinear Optics; P.E.Powers, CRC Press Francis and Taylor (2011)
2. Principles of Nonlinear Optics; Y.R.Shen
3. Nonlinear Optics: Robert Boyd, Academic press
4. Physics of Nonlinear Optics: Guang- Sheng –He and So ng-Hao Lin; World scientific.
5. Two Level Resonances in Atoms; Allen and J.H. Emberly, John Wiley.

SAP 4029 Introduction to Nanophotonics

[3-1-0-4]

Module I & II: Foundations for Nanophotonics: similarities and differences of photons and electrons and their confinement. 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, scanning near-field optical microscopy. Nanoscale confinement of electronic interactions: Quantum confinement effects, nanoscale interaction dynamics, nanoscale electronic energy transfer. Cooperative emissions. [12]

Module III: Quantum wells, quantum wires, quantum dots, quantum rings and superlattices. Quantum confinement, density of states, optical properties. Quantum confined Stark effect. Dielectric confinement effect. Core-shell quantum dots and quantum-dot-quantum wells. Quantum confined structures as lasing media. Organic quantum-confined structures. [8]

Module IV: Photonic Crystals: basic concepts, features of photonic crystals, wave propagation, photonic band-gaps, light guiding. Theoretical modeling of photonic crystals. Methods of fabrication. Photonic crystal optical circuitry. Nonlinear photonic crystals. Applications of photonic crystals. [6]

Module V: Microstructure fibers: photonic crystal fiber (PCF), photonic band gap fibers (PBG), band gap guiding, single mode and multi mode, dispersion engineering, nonlinearity engineering, PCF devices. [6]

Module VI: Plasmonics: 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. [8]

Module VII: Nanophotonic Devices: Quantum well lasers: 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. [10]

Book:

1. Nanophotonics, Paras N Prasad, John Wiley & Sons (2004)
2. Fundamentals of Photonic Crystal Fibers; Fredric Zolla- Imperial College Press.
3. Photonic Crystals; John D Joannopoulos, Princeton University Press.
4. Photonic Crystals: Modelling Flow of Light; John D Joannopoulos, R.D. Meade and J.N. Winn, Princeton University Press (1995)

SAP 4031 Photonic and Optoelectronic Devices

[3-1-0-4]

Module I: Optical processes in semiconductors: Electron-hole pair formation and recombination, Direct and indirect bandgap semiconductors, optoelectronic materials, compound semiconductors, absorption in semiconductors, Stark effects, Absorption and emission spectra, Stokes shift in optical transitions, exciton recombination. [8]

Module II & III: Optical sources: Light emitting diodes, surface and edge emitting configuration. Injection laser diodes, gain and index guided lasers, vertical cavity lasers, DFB lasers, Quantum well lasers, Laser rate equations, Laser modes, Q-switching, Mode locking. [12]

Module IV: Optical modulators and switches: Electro-optic modulator, Magneto-optic modulator, Acousto-optic modulator. Electro-absorption modulators, Mach-Zehnder Electrorefraction (Electrooptic) modulators, Lithium Niobate light modulators, optical switches. [8]

Module V: Optical Detectors: PIN and avalanche photodiodes, Photoconductors, Phototransistors, noise in photodetector. Solar cells (spectral response, conversion efficiency), Charge couple devices, Characteristics and applications. [10]

Module VI: Optical computing: Digital optical computing: Nonlinear devices, optical bistable devices, SEED devices, Optical phase conjugate devices, integrated devices, spatial light modulators(SLM). [10]

Module VII: Photonic switching and interconnects: Kerr gates, Nonlinear Directional couplers, Nonlinear optical loop mirror (NOLM), Soliton logic gates, Free-space optical interconnects, wave-guide interconnects. [10]

Books:

1. Essentials of optoelectronics, Alan Rogers, 1st Ed., Chapman & Hall.
2. Introduction to Fiber Optics, Ghatak & Thyagarajan, Cambridge University press.
3. Semiconductor Optoelectronics Devices, P. Bhattacharya, PHI.
4. Optoelectronics and Photonics, principles and practices S. O. Kasap, Prentice Hall
5. Photonic switching and Interconnects; Abdellatif Marrakchi, Marcel Dekker, Inc.
6. Optical Computing, an Introduction, Mohammad A. Karim and Abdul A. S. Awwal, John Wiley & Sons Inc.

SAP 4033 Holography and Applications

[3-1-0-4]

Module-I: Basics of Holography: In line Hologram, off axis hologram, Fourier Hologram, Lenses Fourier Hologram, Image Hologram, Fraunhofer Hologram. Holographic interferometry, double exposure hologram, real-time holography, digital holography, holographic camera. [8]

Module-II: Theory of Hologram: Coupled wave theory, Thin Hologram, Volume Hologram, Transmission Hologram, Reflection Hologram, Anomalous Effect. [8].

Module-III&IV:Recording Medium: Microscopic Characteristics, Modulation transfer function, Diffraction efficiencies, Image Resolution, Nonlinearities, S/N ratio, Silver halide emulsion, Dichromated gelatin, Photoresist, Photochrometics, Photothermoplastics, photorefractive crystals. [13]

Module-V&VI:Applications: Microscopy, interferometry, NDT of engineering objects, particle sizing, holographic particle image velocimetry; imaging through aberrated media, phase amplification by holography; Optical testing; Information storage. [13]

Module-VII: Holographic Optical Elements(HOE): multifunction, holographic lenses, holographic mirror, holographic beam splitters, polarizing, diffuser, interconnects, couplers, scanners; Optical data processing, holographic solar connectors; antireflection coating, holophotoelasticity; [8]

Book:

1. Optical Holography, Principle Techniques and applications: P. Hariharan, Cambridge University Press.
2. Holographic Recording materials; H.M.Smith, Springer Verlag