Program Structure of B. Sc. (Hons.) Physics

Semester-I

S. No.	Code	Subject Name	L	T	P	Credits
1	BECT 1101	English Communication	2	-	2	3
2	BCST 1101	Computer Fundamentals & Office Automation	3	-	2	4
3	BMAT 1101	Principles of Mathematics-I	3	1	-	4
4	BPHT 1101	Principles of Physics	3	-	-	3
5	BCYT 1101	Principles of Chemistry	3	-	-	3
6	BPHT 1102	Mechanics & Relativity	3	-	-	3
7	BPHL 1101	Physics Practical - I	-	-	4	2
8	BCYL 1101	Chemistry Practical	-	-	4	2
		ALL	17	1	12	24
	Total Period		30			

Semester-II

S. No.	Code	Subject Name	L	T	P	Credits
1	BMAT 1201	Principles of Mathematics-II	3	1	-	4
2	BPHT 1201	Mathematical Physics-I (Vector Analysis and Fourier Series)	4	-	-	4
3	BPHT 1202	Oscillations & Waves	4	-	-	4
4	BRST 1201	Radiology & Safety	4	-	-	3
5	BRST 1201	Renewable Energy & Energy Harvesting	4	-	-	3
6	BSSS 1201	Soft Skills - I	2	-	2	3
7	BEST 1201	Environmental Studies	3	-	-	3
8	BPHL 1201	Physics Practical-II	-	-	3	2
		ALL	24	1	5	26
	Total Period		30			

Semester-III

S. No.	Code	Subject Name	L	T	P	Credits
1	BPHT 2101	Mathematical Physics-II (Differential Equations and Calculus of variation)	3	1	-	4
2	BPHT 2102	Optics	3	-	-	3
3	BPHT 2103	Electricity and Magnetism	3	-	-	3
4	BPHT 2104	Thermal Physics	3	-	-	3
5	BPHT 2105	Quantum Mechanics	3	-	-	3
6	BPHT 2106	Solid State Physics	3	-	-	3
7	BSSS 2101	Soft Skills - II	2	-	2	3
8	BPHL 2101	Optics Lab	-	-	4	2
9	BPHS 2101	Seminar	-	-	3	2
		ALL	20	1	9	26
	Total Period		30			

Semester-IV

S. No.	Code	Subject Name	L	T	P	Credits
1	BPHT 2201	Mathematical Physics-III (Complex Analysis and Special functions)	3	1	-	4
2	BPHT 2202	Electronic Devices	3	-	-	3
3	BPHT 2203	Electrical Circuit & Networks	3	-	-	3
4	BMAT 2201	Numerical Analysis	3	-	-	3
5	BSSS 2201	Soft Skills - III	2	-	2	3
6	BPHL 2201	Electronics Device Lab	-	-	4	2
7	BMAL 2201	Numerical Analysis Lab	-	-	4	2
8	BPHP 2201	Project (Minor): (Report, Seminar, Viva-voce)	-	-	4	2
		ALL	14	1	14	22
	Total Period		29			

Summer Internship Program – (8 weeks)

S. No.	Code	Subject Name	Credit
1	BPHP 2202	SIP: (Report, Seminar & Viva-Voce)	6

Semester-V

S. No.	Code	Subject Name	L	T	P	Credit
1	BPHT 3101	Mathematical Physics-IV(Linear Algebra and Partial Differential Equation)	3	1	-	4
2	BPHT 3102	Digital Electronics	3	-	-	3
3	BMCT 3101	Microprocessor and Computer Programming	3	-	-	3
4	BPHT 3103	Atomic and Molecular Physics	3	-	-	3
5	BPHT 3104	Laser Physics	3	-	-	3
6	BSSS 3101	Soft Skills - IV	2	-	2	3
7	BMCL 3101	Microprocessor & Computer Lab	-	-	4	2
8	BPHL 3101	Digital Electronics Lab	-	-	4	2
		ALL	17	1	10	23
	Total Period		28			

Semester-VI

S. No.	Code	Subject Name	L	T	P	Credit
1	BPHT 3201	Electromagnetic Theory	3	-	-	3
2	BPHT 3202	Statistical Physics	3	-	-	3
3	BPHT 3203	Nuclear and Particle Physics	3	-	-	3
4	BPHT 3204	Introduction to Nanoscience and Nanotechnology	3	-	-	3
5	BPHT 3205	Material Science	3	-	-	3
6	BSSS 3201	Soft Skills - V	2	-	2	3
7	BCPL 3201	Computer Programming Lab	-	-	4	2
8	BPHP 3201	Project (Report, Seminar & Viva-voce)	-	-	7	6
		ALL	17	-	13	26
	Total Period		30			

Semester I

Course: English Communication			**Semester: I**
Course Code: BECT 1101	**L T P**	**2 0 2**	**Credits: 3**

Objective: To enable students to improve both the ability to communicate and the linguistic competence in the chosen language. A balance of receptive (reading, listening) and productive (speaking, writing) skills are developed through communicative classes and self-study.

Communication 10

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

Writing Skills 12

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

Technical Writing 12

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

Suggested Readings

1. M. Frank. *Writing as thinking: A guided process approach,* Phoenix ELT (1989).
2. L. Hamp-Lyons and B. Heasely, *Study Writing: A Course in Written English for Academic Purposes*, Cambridge Univ. Press (2006).
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik, *A comprehensive grammar of the English language*, 2nd Revised ed., Longman (1985).
4. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition Dreamtech Press, (2004)
5. Scot Ober, *Contemporary Business Communication* 7th edition, Houghton Mifflin (2007).

Course: Computer Fundamentals & Office Automation			Semester: I
Course Code: BCST 1101	**L T P**	**3 0 2**	**Credits: 4**

Objective: To provide students an in-depth training in the use of office automation packages, internet etc. essential for common man for day to day office management, and e-governance. This course will enable students to understand computer, the basics of Operating systems, software packages in day to day activities, the essential and use of internet.

Introduction to Computer 8

Definition - History & Generation of Computer (From First to 5th) - CD, DVD, Blue ray Disc, Pen Drive Magnetic tape & Zip disk – CPU: Components of CPU - Mother board, Hard disk, RAM, ROM, Processor, SMPS & Connecting wire - Graphics Card, Sound Card, Network Card – Modem; Input, Output devices: Keyboard, Mouse, Scanner, Digital Camera, Joystick, Pen drive, Monitor, Printer, Plotter - Floppy Drive – Connecting port – Serial, parallel – USB port. Computer Networks: Data Communications –Types of Computer Networks – Local Area Networks & Wide Area Networks.

Windows 8

Definition of Operating System - Functions of OS - Types of OS: Single user, Multi-User, multi-task, RTOS, Single-user, Multi-tasking – Windows Desk top - GUI: Definition, Standards, Cursors/Pointers, Icons, GUI Menus, GUI-Share Data – Desktop icons and their functions: My computer, Creating & Editing Images with Microsoft paint, using the Calculator – Personalising Windows. Linux: Linux Programming & Administration: Introduction to Linux – Features of Linux – Components of Linux – Linux process and Thread Management – File Management System; Linux Commands and Utilities – cat, tail, cmp, diff, wc, sort, mkdir, cd, rmdir, pwd, cp, more, passwd, who, whoami, mv, chmod, kill, write, wall, merge, mail, news – pipes, filters and redirection utilities; System Administration: Installing Linux – Booting the system – Maintaining user accounts – File systems and special files – Backups and restoration.

Introduction to MS Word 8

MS Word, Working with Documents, Opening & Saving files, Editing text documents, Inserting, Deleting, Cut, Copy, Paste, Undo, Redo, Find, Search, Replace, Formatting page & setting Margins, Anchoring & Wrapping, Setting Document styles, Table of Contents, Index, Page Numbering, date & Time, Author etc., Creating Master Documents, Web page. Creating Tables- Table settings, Borders, Alignments, Insertion, deletion, Merging, Splitting, Sorting, and Formula, Drawing - Inserting Clip Arts, Pictures/Files etc., Tools – Word Completion, Spell Checks, Mail merge, Templates, Creating contents for books, Creating Letter/Faxes, Creating Web pages, Using Wizards, Tracking Changes, Security, Digital Signature. Printing Documents – Shortcut keys.

MS Excel 8

Spread Sheet & its Applications, Opening Spreadsheet, Menus - main menu, Formula Editing, Formatting, Toolbars, Using Icons, Using help, Shortcuts, Spreadsheet types. Working with Spreadsheets- opening, Saving files, setting Margins, Converting files to different formats (importing, exporting, sending files to others), Spread sheet addressing - Rows, Columns & Cells, Referring Cells & Selecting Cells – Shortcut Keys. Entering & Deleting Data- Entering data, Cut, Copy, Paste, Undo, Redo, Filling Continuous rows, columns, Highlighting values, Find, Search & replace, Inserting Data, Insert Cells, Column, rows & sheets, Symbols, Data from external files, Frames, Clipart, Pictures, Files etc,

Inserting Functions, Manual breaks, Setting Formula - finding total in a column or row, Mathematical operations (Addition, Subtraction, Multiplication, Division, Exponentiation), Using other Formulae. Formatting Spreadsheets, Introduction to MS Office-MS Access and Open Office-Base: MS Access: Introduction, planning a Database, Starting Access, Access Screen, Creating a New Database, Creating Tables, Working with Forms, Creating queries, Finding Information in Databases, Creating Reports, Types of Reports, Printing & Print Preview – Importing data from other databases viz. MS Excel etc.

Introduction to MS Office-MS Power Point and Open Office-Impress 8

MS Power point: Introduction to presentation, opening new presentation, Different presentation templates, Setting backgrounds, Selecting presentation layouts. Creating a presentation - Setting Presentation style, Adding text to the Presentation. Formatting a Presentation - Adding style, Colour, gradient fills, Arranging objects, Adding Header & Footer, Slide Background, Slide layout. Adding Graphics to the Presentation- Inserting pictures, movies, tables etc into presentation, Drawing Pictures using Draw. Adding Effects to the Presentation- Setting Animation & transition effect. Printing Handouts, Generating Standalone Presentation viewer. OpenOffice-Impress - Introduction – Creating Presentation, Saving Presentation Files, Master Templates & Re-usability, Slide Transition, Making Presentation CDs, Printing Handouts – Operating with MS Power Point files / slides

Suggested Readings

1. V. Rajaraman, *Fundamentals of Computers*, 5th edition, PHI Learning (2010).
2. P.K. Sinha, Priti Sinha, *Computer Fundamentals*, BPB Publications (1992).
3. Suresh Basandra, *Computer Today*, Galgotia Publications Pvt. Ltd. (2010).
4. Sumitabha Das, *Unix Concepts and Application*, 4th edition, McGraw Hill Education (2006)
5. Steve Sagman, *MS-Office 2000(For Windows)*, 1st edition, Peachpit Press (1999).
6. Tennenbum, *Computer Networks,* 5th edition, Pearson (2012).

Course: Principles of Mathematics – I			Semester: I
Course Code: BMAT 1101	**L T P**	**3 1 0**	**Credits: 4**

Objective: To emphasize conceptual understanding of elementary mathematical methods and ideas among the students. This course include numbers, operations, proportional reasoning, number theory, algebra, geometry, measurement, data analysis, and probability.

Matrix Algebra 15

Symmetric, Skew-Symmetric, Hermitian and skew-Hermitian matrices, Orthogonal and Unitary matrices, Elementary operations on matrices, Inverse of a matrix, Cramer's Rule, Linear dependence of rows and columns of a matrix, Row rank, column rank and their equivalence, Rank of a matrix, Applications of matrices in solving system of linear (both homogeneous and non-homogeneous) equations, Conditions of consistency for a system of linear equations.

Eigen vectors, Eigen values and the characteristics equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix, Powers of Matrices, Orthogonal matrices. Diagonalization of Matrices.

Differential calculus 15

Indeterminate forms, L'Hôpital's rule. A brief review of limit, Continuity and differentiability, successive differentiation, Taylor's and Maclaurin's series expansions, Tangents and normals of polar curves, Derivatives of arc, Asymptotes, Curvature, Double Points, Curve tracing.

Functions of two variables, Partial differentiation and change of independent variables (two variables), Jacobians (simple applications-function of a function case), Maxima and Minima of two independent variables

Integral calculus 10

Integral as limit of a sum, Fundamental theorem of integral calculus(statement only), Beta and Gamma Functions, Change of order of integration in double integrals, Drichlet's theorem and its Liovelle's extension.

Multiple integrals, Area (quadrature), Rectification (length of curves), Volumes and Surfaces, Differentiation and integration under the integral sign

Suggested Readings

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M. Ray, S. S. Sharma and G. C. Sharma, *Differential Calculus*, Shiva Lal Agarwala & Company.
3. H. S. Dhami: *Differential Calculus*, New Age International, New Delhi
4. T. M. Apostol: *Calculus*, John Willey and Sons, New York
5. Gorakh Prasad: *Differential Calculus*, Pothishala publication, Allahabad.
6. M. Ray: *Integral Calculus*, Shiva Lal Agarwal and Co., Agra
7. H. S. Dhami: *Integral Calculus*, New Age International, New Delhi
8. Gorakh Prasad: *Integral Calculus*, Pothishala Publication, Allahabad.
9. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
10. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
11. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

Course: Principles of Physics			Semester: I
Course Code: BPHT 1101	**L T P**	**3 0 0**	**Credits: 3**

Objective: To introduce students a knowledge of physical phenomena, an understanding of physical principles and the experimental basis of the various fields of physics and the logical relationships of the various fields. This course will enable students to formulate and tackle problems in physics, including the identification of appropriate physical principles and the use of special and limiting cases and order-of-magnitude estimates, to arrive at a solution which is presented with an explicit statement of assumptions and approximations.

Mathematical Physics 11

Scalar and vector products, polar and axial vectors, triple and quadruple products.

*Vector calculus***:** Scalar and vector fields, differentiation of a vector, gradient, divergence, curl and Δ operations and their meaning, idea of line, surface and volume integrals, Gauss and Stokes' theorem.

Classical Mechanics 15

Particle dynamics: Newton's laws of motion, conservation of linear momentum, center of mass, conservative forces, work energy theorem, particle collision.

Rotational kinematics and dynamics: Rotational motion, forces and pseudo forces, torque and angular momentum, kinetic energy of rotation, rigid body rotation dynamics, moment of inertia, conservation of angular momentum, comparison of linear and angular momentum, motion of a top.

Oscillations: Linearity and superposition principle, free oscillation with one and two degrees of freedom, simple pendulum, combination of two simple harmonic motions. Lissajous figures, free and damped vibrations, forced vibrations and resonance, Q factor, wave equation, travelling and standing waves, superposition of waves, phase and group velocity.

Wave optics 15

Interference, division of amplitudes, Young's double split, Fresnel's biprism, interference in thin films and wedged shaped films.

Fresnel diffraction: Diffraction at a single slit and a circular aperture, diffraction at a double split, plane transmission grating, resolving power of a telescope and a microscope, resolving and dispersive power of a plane diffraction grating.

Polarization: Polarization by reflection and refraction, Brewster's law, double refraction, Nicol prism, quarter and half-wave plates, Production and analysis of circularly and elliptically polarized light.

Suggested Readings

1. M. R. Spiegel, *Vector Analysis* Schaum's Outline Series. McGraw-Hill Book Co., Singapore (1974)
2. Satya Prakash, *Mathematical physics*, Sultan Chand & Sons; Sixth edition (2014).
3. B. S. Rajput, Mathematical Physics, Pragati Prakashan (2015).
4. A. K. Ghatak, *Optics*, Tata McGraw-Hill Education (2005).
5. N. Subhramanyam, Brijlal, M. N. Avadhanulu, *A Text book of Optics*, S. Chand publication. (2004).
6. A. Beiser, *Concepts of Modern Physics* McGraw-Hill Education (2002).
7. R. Resnick, D. Halliday, & K. S. Krane, *Physics Vol. I and II* 5th Ed. John Wiley & Sons (2004).

Course: Principles of Chemistry			Semester: I
Course Code: BCYT 1101	**L T P**	**3 0 0**	**Credits: 3**

Objective: To enable students to understand and explain the general principles, laws, and theories of chemistry. This course will develop chemistry skills through technological advancement.

Structure and Bonding 4

Basic concepts of elements and compounds. Electronic structure of atoms, Different types of bonding, Qualitative approach to Valence Bond Theory and its Limitations. Hybridization, Equivalent and Non-equivalent Hybrid Orbitals.

Molecular Orbital Theory 4

Symmetry and Overlap, Molecular Orbital Diagrams of diatomic
and simple polyatomic systems (O_2, C_2, B_3, CO, NO and their ions; HCL, BeF_2, CH_4, BCl_3) (Idea of Sp3 Mixing and Orbital Interaction to be given).

Packing in Crystals 4

Close Packed Structures. (1) Spinal, (2) Ilmenite and (3) Perovskite Structures of Mixed Metal Oxides. Size Effects, Radius, Ratio Rules and their Limitations.Lattice Energy : Born Equation (Calculations of Energy in Ion Pair and Ion-pairs Square Formation), Madelung Constant. Kapustinskii Equation and its Applications. Born-Haber Cycle and its Applications.

Weak Chemical Forces 4

Van-der-Waals Forces, Hydrogen Bonding. Effects of Chemical Forces on M.P., B.P., and Solubility. Energetics of Dissolution Process.

Oxidation-reduction reactions 4

Oxidation number, oxidizing and reducing agents, balancing redox reactions, calculations involving redox reactions.

Stereochemistry 4

Bonding in Organic Molecules and its effects on Shape Chirality and RS Nomenclature as applied to Chiral Centers. Treatment of Chirality upto three chiral centers. Conformation of Acyclic and Cyclic Systems, Conformational Analysis of Di-substituted Cyclohexanes. Geometrical Isomerism and E-2 Nomenclature.

Reaction Mechanism in Organic Chemistry 4

Electronic Displacements in Organic Molecules.Aromaticity. Reactivity of Organic Molecules. Heterolytic and Hemolytic Fission.Nucleophiles, Electrophiles, Acids and Bases and their Relative Strengths (including Carbon Acids). Addition, Elimination and Substitution Reactions (including Electrophilic, Nucleophilic and Aromatic Types). Arynes and Carbenes as Reaction Intermediates.

Functional Group Chemistry 4

Functional Group. Orientation Effect in Aromatic Substitution. Groups. (1) Hydroxyl Group, (2) Phenol, (3) Carbonyl Group, (4) Carboxylic Acid Group and its Derivatives : Esters and Amides, (5) Cyno Group, (6) Nitro Group, and (7) Amino Group.

Organic Reactions 4

(1) Aldol Condensation, (2) Cannizaro Reaction, (3) Claisen Condensation, (4) Darzen Reaction, (5) Dickermann Reaction, (6) Grignard Synthesis, (7) Mannich Reaction, (8) Michael Reaction, and (9) Perkin Reaction, etc.

Polymerization 4

Types of Polymerization. Forms of Polymers. (1) Condensation Polymerization, (2) Ring Opening Polymerization, (3) Addition Polymerization, and (4) Zieglar-Natta Polymerization. Natural and Synthetic Rubbers.

Suggested Readings

1. P S Sindhu, *Modern Chemisty*, S. Chand & Sons.
2. J.D. Lee, *A New Conscise Inorganic Chemistry*, E.L.B.S.
3. I.L. Finar, *Organic Chemistry*, (Vol. I & II), E.L.B.S.
4. R.T. Morrison & R.N. Boyd, *Organic Chemistry*, Prentice Hall.
5. Arun Bahl and B.S. Bahl, *Advanced Organic Chemistry*, S. Chand.
6. T.W. Graham Solomons, *Organic Chemistry*, John Wiley and Sons.

Course: Mechanics & Relativity			Semester: I
Course Code: BPHT 1102	**L T P**	**3 0 0**	**Credits: 3**

Objective: To understand basic principles of various mechanical operations, construction and working of the equipments. This course also includes the concept of special relativity and its applications to Physical Sciences; and provide students with knowledge and proof of the validity of Physical Laws and nonexistence of the hypothetical stationary aether.

Fundamentals of Dynamics 3

Dynamics of a System of Particles. Centre of Mass. Conservation of Momentum. Idea of Conservation of Momentum from Newton's Third Law. Impulse. Momentum of Variable Mass System: Motion of Rocket.

Work and Energy Theorem 9

Work and Kinetic Energy Theorem. Conservative and Non- Conservative Forces. Potential Energy. Energy Diagram. Stable and Unstable Equilibrium. Gravitational Potential Energy. Elastic Potential Energy. Force as Gradient of Potential Energy. Work and Potential energy. Work done by Non-conservative Forces. Law of Conservation of Energy.
Elastic and Inelastic Collisions between particles. Centre of Mass and Laboratory Frames.

Rotational Dynamics 6

Angular Momentum of a Particle and System of Particles. Torque. Conservation of Angular Momentum. Rotation about a Fixed Axis. Moment of Inertia. Calculation of Moment of Inertia for Rectangular, Cylindrical, and Spherical Bodies. Kinetic Energy of Rotation. Motion involving both Translation and Rotation.

Gravitation and Central Force Motion 9

Law of gravitation. Inertial and Gravitational Mass. Potential and Field due to Spherical Shell and Solid Sphere. Motion of a Particle under Central Force Field. Two Body Problem and its Reduction to One Body Problem and its Solution. The Energy Equation and Energy Diagram. Kepler's Laws (Ideas Only). Orbits of Artificial Satellites.

Elasticity 3

Relation Between Elastic Constants. Twisting Torque on a Cylinder or Wire.

Fluid Motion

Kinematics of Moving Fluids 2

Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Inertial and Non- Inertial Systems 6

Reference Frames

Inertial Frames and Galilean Transformations. Galilean Invariance and Conservation Laws. Non-inertial Frames and Fictitious Forces. Uniformly Rotating Frame. Physics Laws in Rotating Coordinate Systems. Centrifugal forces: Coriolis Force and its Applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Special theory of Relativity 10

Michelson-Morley Experiment and its Outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and Order of Events. Lorentz Contraction. Time Dilation. Relativistic Transformation of Velocity, Frequency and Wave Number. Relativistic Addition of Velocities. Variation of Mass with Velocity. Rest Mass. Massless Particles.

Mass- energy Equivalence. Bucherer's experiment. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

Suggested Readings

1. Daniel Kleppner, Robert J. Kolenkow, *An introduction to mechanics*, McGraw-Hill (1973)
2. Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz, Burton Moyer, *Mechanics* Berkeley physics course, v.1, Tata McGraw-Hill (2007).
3. D S Mathur, *Mechanics*, S. Chand & Company Limited (2000).
4. Keith R. Symon, *Mechanics*, 3rd edition, Addison Wesley (1971).
5. F W Sears, M W Zemansky and H D Young, *University Physics,* Narosa Publishing House (1982).

Course: Physics Practical – I			Semester: I
Course Code: BPHL 1101	**L T P**	**0 0 4**	**Credits: 2**

Objective: To familiarize students with experimental apparatus, the scientific method, and methods of data analysis so that they will have some idea of the inductive process by which the ideas were originated. This course will also enable students how to make careful experimental observations and how to think about and draw conclusions from such data

Errors in Measurements

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

List of Practicals

A: General

1. To use a Multimeter for measuring (a) Resistances, (b) A/C and DC Voltages, (c) AC and DC Currents, (d) Capacitances, and (e) Frequencies.
2. To test a Diode and Transistor using (a) a Multimeter and (b) a CRO.
3. To measure (a) Voltage, (b) Frequency and (c) Phase Difference using a CRO.
4. To study the Characteristics of a Series RC Circuit.
5. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.
6. To convert a given ammeter into a voltmeter and a given voltmeter into an ammeter and hence to calibrate the device and measure the internal resistance in each case.
7. To measure the resistance per unit length of the wire of a bridge and to determine an unknown resistance by Carey Fosters bridge.
8. To measure the current flowing in a circuit by measuring the drop of potential across a known resistance in the circuit using a potentiometer (by measuring the resistance of the potentiometer with a P.O. Box).

B: Mechanics

1. To determine the Acceleration due to Gravity and Velocity for a freely falling body, using Digital Timing Techniques.
2. Determination of moment of inertia of metallic cylinder / rectangular bar about an axis passing through its C.G. and to determine the rigidity modulus of the material of the suspension wire.
3. Determination of refractive index of a liquid by using travelling microscope.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Young's Modulus of a Wire by Optical Lever Method.
7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
8. To determine the Elastic Constants of a Wire by Searle's method.

Note

Each Student is required to perform at least 10 Practicals by taking at least 5 Practicals from each from **A** and **B**.

Suggested Readings

1. Geeta Sanon, *BSc Practical Physics*, 1st Edn. R. Chand & Co. (2007).
2. B. L. Worsnop and H. T. Flint, *Advanced Practical Physics*, Asia Publishing House, New Delhi.
3. Indu Prakash, Ramakrishna and A. K. Jha, *A Text Book of Practical Physics*, Kitab Mahal, New Delhi (2012).
4. D. P. Khandelwal, *A Laboratory Manual of Physics for Undergraduate Classes*, Vani Publication House, New Delhi (1985).
5. C. L. Arora, *B.Sc. Practical Physics*, S. Chand Limited (1995).

Course: Chemistry Practical			Semester: I
Course Code: BCYL 1101	**L T P**	**0 0 4**	**Credits: 2**

Objectives: To introduce students a broad set of chemical knowledge concerning the fundamentals in the basic areas of the discipline (organic, inorganic, analytical, physical and biological chemistry). This course will enable students to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

List of Practicals

1. Colorimetric estimation of total iron using 1, 10-phenanthroline
2. Determination of ferrous ion in a solution using ferroin indicator
3. Determination of zinc by using potassium ferrocyanide
4. Estimation of strength of oxalic acid using potassium permanganate as intermediate solution
5. Determination of ph curve of an acid base titration and dissociation constant of weak acid.
6. Dissociation constant of weak electrolyte by conductometry.

7. Preparation of

(i) Aspirin (ii) Hippuric Acid (Benzoylglycine) (iii) Methyl Orange or Phenolphthalein. Characterisation by mp, mmp, and TLC.

8. Two-step Preparations

(i) Nitrobenzene from Benzene, Purification of Nitrobenzene and characterization by refractive index, further nitration.

(ii) *P*-bromoacetanilide from Aniline.

9. Estimation of Glucose, Saponification Value or Iodine Value of a fat or oil.

10. The effect of Detergent on the Surface Tension of Water. (Variation of Surface Tension with Concentration to be studied).

11**.** Determination of the Rate Law for one of the following reactions. All solutions needed to be provided.

(i) Persulphate-iodine Reaction.

(ii) Iodination of Acetone.

Suggested Readings

1. A.I. Vogel, *Text-Book of Practical Organic Chemistry*, Prentice Hall 5th Edition.
2. A.I. Vogel, *Qualitative Chemical Analysis*, Prentice Hall 6th Edition.
3. A.I. Vogel, *Qualitative Inorganic Analysis*, Prentice Hall 7th Edition.
4. F.G. Mann & B.C. Saunders, *Practical Organic Chemistry*, Orient Longman.

Semester II

Course:	**Principles of Mathematics –II**		**Semester: II**
Course Code: BMAT 1201	**L T P**	**3 1 0**	**Credits: 4**

Objectives: To introduce students the concept of calculus, differential equations and their applications. The course also contains the applications of vector calculus, complex integrations in various physics problems.

Ordinary Differential Equations 5

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

Vector Calculus 5

Gradient Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields– Vector integration – Green's theorem in a plane, Gauss divergence theorem and stokes'theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelpipeds.

Analytic Functions 10

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping : w= z+c, cz, 1/z, and bilinear transformation.

Complex Integration 10

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor and Laurent expansions – Singular points – Residues – Residue theorem – Application of residue theorem to evaluate real integrals – Unit circle and semicircular contour(excluding poles on boundaries).

Laplace Transform 10

Laplace transform – Conditions for existence – Transform of elementary functions – Basic properties – Transform of derivatives and integrals – Transform of unit step function and impulse functions – Transform of periodic functions. Definition of Inverse Laplace transform as contour integral – Convolution theorem (excluding proof) – Initial and Final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

Suggested Readings

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., (2011).
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, (2011).
3. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., (2011).
4. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, (2012).
5. Peter V. O"Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, (2012).

6. Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, New Delhi, (2008).
7. Sivarama Krishna Das P. and Rukmangadachari E., “Engineering Mathematics” Volume II, Second Edition, PEARSON Publishing, (2011).

Course: Mathematical Physics-I (Vector Analysis and Fourier Series)			Semester: II
Course Code: BPHT 1201	**L T P**	**4 0 0**	**Credits: 4**

Objective: To introduce students to the use of mathematical methods to solve physics problems; and provide students with basic skills necessary for the application of mathematical methods in physics

Vector Calculus

Vector Differentiation 12

Scalar and Vector Fields. Ordinary and Partial Derivative of a Vector w.r.t. Coordinates. Space Curves. Unit Tangent Vector and Unit Normal Vector (without Frenet - Serret Formulae). Directional Derivatives and Normal Derivative. Gradient of a Scalar Field and its Geometrical Interpretation. Divergence and Curl of a Vector Field. Del and Laplacian Operators. Vector Identities.

Vector Integration 8

Ordinary Integral of Vectors. Line, Surface and Volume Integrals. Flux of a Vector Field. Gauss' Divergence Theorem, Green's Theorem and Stokes Theorem.

Orthogonal Curvilinear Coordinates 5

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Multiple Integrals 6

Double and Triple Integrals: Change of Order of Integration. Change of Variables and Jacobian. Applications of Multiple Integrals: (1) Area Enclosed by Plane Curves, (2) Area of a Curved Surface, (3) Volumes of Solids.

Some Special Integrals 5

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Fourier Series 10

Fourier Series. Dirichlet Conditions (Statement only). Kronecker's Method for Computation of Fourier Coefficients. Even and Odd Functions. Orthogonality of Sine and Cosine Functions. Sine and Cosine Series. Applications: Square Wave, Triangular Wave, Output of Full Wave Rectifier and other Simple Functions. Summing of Infinite Series Term-by-Term Differentiation and Integration of a Fourier Series.

Suggested Readings

1. George B. Arfken, Hans J. Weber, Frank E. Harris, *Mathematical Methods for Physicists: A Comprehensive Guide*, 7 edition, Academic Press (2011).
2. B. D. Gupta, *Mathematical physics*, Viskas Pub, (1987).
3. Murray Spiegel, Seymour Lipschutz, *Schaum's Outline of Vector Analysis*, 2nd Edn., McGraw-Hill (2009).
4. Satya Prakash, *Mathematical physics*, Sultan Chand & Sons; Sixth edition (2014).
5. H. K. Dass, R. Verma, M*athematical physics*, S Chand (2010).
6. B S Grewal, *Higher Engineering Mathematics*, Khanna Publishers (2000).

Course: Oscillations & Waves			Semester: II
Course Code: BPHT 1202	**L T P**	**4 0 0**	**Credits: 4**

Objective: To provide students an understanding of oscillations and waves and an appreciation of their importance in the study of physics; to introduce the mathematical tools used in their analysis.

Oscillations 4

SHM:- Simple Harmonic Oscillations. Differential Equation of SHM and its Solution. Amplitude, Frequency, Time Period and Phase. Velocity and Acceleration. Kinetic, Potential and Total Energy and their Time Average Values. Reference Circle. Rotating Vector Representation of SHM.

Free Oscillations of Systems with One Degree of Freedom 5

(1) Mass-Spring system, (2) Simple Pendulum, (3) Torsional Pendulum, (4) Oscillations in a U-Tube, (5) Compound pendulum: Centres of Percussion and Oscillation, and (6) Bar Pendulum.

Superposition of Two Collinear Harmonic Oscillations 5

Linearity and Superposition Principle. (1) Oscillations having Equal Frequencies and (2) Oscillations having Different Frequencies (Beats). Superposition of N Collinear Harmonic Oscillations with (1) Equal Phase Differences and (2) Equal Frequency Differences.

Superposition of Two Perpendicular Harmonic Oscillations 5

Superposition of Two Mutually Perpendicular Simple Harmonic Motions with Frequency Ratios 1:1 and 1:2 using Graphical and Analytical Methods. Lissajous Figures and their Uses.

System with Two Degrees of Freedom 6

Coupled Oscillators. Normal Coordinates and Normal Modes. Energy Relation and Energy Transfer. Normal Modes of N Coupled Oscillators.

Free Oscillations, Damped Oscillations 6

Damping Coefficient, Log Decrement. Forced Oscillations: Transient and Steady States, Amplitude, Phase, Resonance, Sharpness of Resonance, Power Dissipation and Quality Factor. Helmholtz Resonator.

Waves

Wave Motion 10

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves Ripple and Gravity Waves.

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Superposition of Two Harmonic Waves 7

Standing (Stationary) Waves in a String, Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes wrt Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's

Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Suggested Readings

1. A. P. French, *Vibrations and Waves*, CBS Pub. & Dist. (1987).
2. N.K. Bajaj, *The Physics of Waves and Oscillations,* Tata McGraw-Hill (1988).
3. K. Uno Ingard, *Fundamentals of Waves & Oscillations*, Cambridge University Press, (1988)
4. Daniel Kleppner, Robert J. Kolenkow, *An Introduction to Mechanics*, McGraw-Hill (1973).
5. Franks Crawford, *Waves: Berkeley Physics Course,* Tata McGraw-Hill (2007).

Course: Radiology & Safety			Semester: II
Course Code: BRST 1201	**L T P**	**4 0 0**	**Credits: 3**

Objectives: To introduce students to x-radiation and safety principles involved in using x-ray machines. This course will also introduce students the basic radiological protective principles as set out by the International Commission on Radiological Protection (ICRP) in 1991 (ICRP Publication No. 60).

Types of Radiation 10

Electromagnetic Spectrum, Production of X rays, X ray Spectra, Brehmsstrahlung characteristic X ray, X ray Tube, Coolidge tube, X ray Tube design, tube cooling , stationary mode Rotating anode X ray tubes Tube rating quality and Intensity of X rays, X ray generator Circuit , half wave and full wave rectification ,filament circuit, kilo voltage circuit , high frequency generator , exposure timers HT cables .

Radiation Physics 15

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β decay - energy released. Radiation Units, exposure, absorbed dose, rad, gray, kera, relative biological effectiveness, effective dose, sievert, inverse square Law, interaction of Radiation with matter linear attenuation coefficient, Radiation Detectors, Thisble Chamber , condenser Chamber, Geiger Counter, Scintillation Counter Ionization Chamber, dosimeter, survey Methods, area Monitors ,TLD and semiconductor Detectors .

Radiation Protection 15

Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles. Protective materials, radiation effects, somatic, genetic, stochastic, and deterministic effect, personal monitoring devices –TLD film badge, pocket Dosimeter. Introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

Suggested Readings

1. K.Thayalan, *Basic of Radiological Physics,* Jaypee Brothers Med Publishing P Ltd New Delhi (2003).
2. K.Thayalan, *Textbook of Radiological Safety,* Jaypee Brothers Med Publishing P Ltd New Delhi (2009).
3. Devon J. Godfrey, Van Dyk Jacob, Shiva K. Das, Curran H. Bruce, Anthony Wolbarst, *Advances in Medical Physics,* Medical Physics Publishing, Incorporated (2016).
4. Harold Elford Johns, John Robert Cunningham, *The Physics of Radiology,* Charles C. Thomas (1983).

Course: Renewable Energy & Energy Harvesting			Semester: II
Course Code: BRET 1201	**L T P**	**4 0 0**	**Credits: 3**

Objective: To introduce students to Why is there a need of renewables worldwide and in Pakistan scenario Basic understanding of wind power system Detailed understanding of PV cells and technologies In depth analysis on PV systems and applications Costing of renewable systems

Energy 8

Sources of energy, classification of energy sources, quality and concentration of an energy source, characteristics temperature. Fossil fuels: coal, oil, gas,nuclear energy. Renewable Energy : geothermal, tidal and. solar, wind, hydropower, biomass. Resources of energy and energy use pattern in different regions of the world.

Ecosystem 8

Origin of the earth, Earth's temperature and atmosphere. Sun as a source of energy, nature of its radiation. Biological processes, photosynthesis. Food chains. Marine ecosystem. Ecosystem theories. Autecology.

Environmental Pollution 10

Mass and energy transfer – Units of measurements – Material balance and energy fundamentals – Environmental chemistry stoichometry, chemical equilibria.Mathematics of growth – Exponential growth, resource consumption and population growth – problems – Consequences of population growth – Classification of pollution – Pollution of air, water and soil – Effect of pollutants on living system – Environmental legislation.

Solid Waste Management 12

Sources and classification – Potential methods of solid waste disposal –Disposal technique adopted for municipal solids wastes – Composting (Natural) – Accelerated composting with industrial sludge.Toxic Waste Management – Problems of industrial hazardous solid waste management in india.incineration of industrial wastes – Treatment of radioactive material.Biomedical wastes – Sources and classification – Various methods of biomedical waste disposal – Biomedical waste rules and regulations – Environmental policy and Eco-labelling.

Water Pollution 10

Water Sources – Origin of waste water – Classification of water pollutants – Effects of water pollutants – Water pollution laws and standards – Water pollution and health – Waste water sampling – BOD – COD analysis – Waste water treatment – Primary treatment – Secondary treatment – Advanced waste water treatment – Anaerobic digestion – Aerobic digestion – Desalination – Micro filtration – Ultra filtration – Reverse osmosis – Environmental policy and Eco-labeling.

Suggested Readings

1. C. S. Rao, *Environmental Pollution Control Engineering,* 2nd Edition, New Age International Publishers (2006).
2. *General Aspects of Energy Management and Energy Audit*, II edition, Bureau of Energy Efficiency, New Delhi, India, (2005).
3. James P. Tomany, *Air Pollution, the Emissions, the Regulations and The Controls*, American Elsevier Environmental Service Series (2007).

Course: Environmental Studies			Semester: II
Course Code: BEST 1201	**L T P**	**3 0 0**	**Credits: 3**

Objectives: To spread awareness among the students about environment and the problems associated with it, and various majors towards the solutions of current problems and prevention of future problems related to the environment.

Environmental Education and Ecosystems 6

Environmental education: Definition and objectives. Structure and function of an ecosystem - ecological succession – primary and secondary succession – ecological pyramids – pyramid of number, pyramid of energy and pyramid of biomass.

Environmental Pollution 12

Pollution – Air, water, soil – causes and effects and control measures. Specially: acid rain, ozone layer depletion, green house gas effect and global warming. Waste management: prevention and control measures of solid waste (general). National concern for environment: Important environmental protection Acts in India – water, air (prevention and control of pollution) act, wild life conservation and forest act. Functions of central and state pollution control boards. Issues involved in enforcement of environmental legislation.

Pollution and Waste Management 10

Introduction: definition - genetic, species and ecosystem diversity - value of biodiversity hot spots – values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values - threats to biodiversity: habitat loss, poaching of wildlife - endangered and endemic species of India, Conservation of biodiversity: in-situ and ex-situ conservations.

Energy Resources and Conservation 10

Energy resources and their exploitation. Conventional energy sources: coal, oil, biomass and nature gas (overview) – over – utilization. Non-conventional energy sources: hydroelectric power, tidal, wind, geothermal energy, solar collectors, photovoltaic, nuclear-fission and fusion. Energy use pattern and future need projection in different parts of the world, energy conservation policies.

Natural Hazards and Disaster Management 5

Natural and Manmade disasters –types, causes, onset, impacts. (viz. earthquake, flood, drought, cyclone, tsunamic, volcanic, landslide, industrial accidents.). Forecasting and managements.

Suggested Readings

1. R. Jeyalakshmi, *Principles of Environmental Studies*, 1st Edition, Devi Publications, Chennai (2006).
2. B. K. Sharma and Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut (1994).
3. A. K. De., *Environmental Chemistry*, New Age International (p) ltd.,New Delhi (1996).
4. S. S. Dara, *A Text Book of Environmenta chemistry and Pollution Control*, Chand & Company Ltd., New Delhi (2004).
5. Dr. Rahavan Nambiar, *Textbook of Environmental Studies*, Second Edition, Scitech Publication (India) Pvt. Ltd.

Course: Physics Practical II			Semester: II
Course Code: BPHL 1201	**L T P**	**0 0 3**	**Credits: 2**

Objective: To provide an experimental foundation for the theoretical concepts introduced in the lectures. This course also introduces the methods used for estimating and dealing with experimental uncertainties, including simple ideas in probability theory and the distinctions between random (statistical) and systematic "errors." This is essential in understanding what valid conclusions can be deduced from experimental data and that, properly obtained, these conclusions are valid, notwithstanding the uncertainty of the data.

List of Practicals

1. To determine g by Bar Pendulum.
2. To determine g by Kater's Pendulum.
3. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g, and (c) Modulus of Rigidity
4. To investigate the Motion of Coupled Oscillators.
5. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment.
6. To verify $\lambda 2 - T$ Law by Melde's Experiment.
7. To determine a Low Resistance by Carey Foster's Bridge.
8. To determine a Low Resistance by a Potentiometer.
9. To determine High Resistance by Leakage of a Capacitor.
10. To determine the (a) Charge Sensitivity and (b) Current Sensitivity of a B.G.
11. To determine the (a) Logarithmic Decrement and (b) CDR of a B.G.
12. To determine the Ratio of Two Capacitances by de Sauty's Bridge.
13. To determine the Dielectric Constant of a Dielectric placed inside a parallel plate capacitor using a B.G.
14. To determine Self Inductance of a Coil by Anderson's Bridge using AC
15. To determine Self Inductance of a Coil by Rayleigh's Method.
16. To determine the Mutual Inductance of Two Coils by Absolute method using a B.G.
17. To study the response curve of a Series LCR circuit and determine its (a) Resonant Frequency, (b) Impedance at Resonance and (c) Quality Factor Q, and (d) Band Width.
18. To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant Frequency and (b) Quality Factor Q.

Note

Each Student is required to perform at least 10 Practicals from the above list.

Suggested Readings

1. Geeta Sanon, *BSc Practical Physics*, 1st Edn. R. Chand & Co. (2007).
2. B. L. Worsnop and H. T. Flint, *Advanced Practical Physics*, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna and A. K. Jha, *A Text Book of Practical Physics*, Kitab Mahal, New Delhi (2012).
4. D. P. Khandelwal, *A Laboratory Manual of Physics for Undergraduate Classes*, Vani Publication House, New Delhi (1985).
5. C. L. Arora, *B.Sc. Practical Physics*, S. Chand Limited (1995).

Semester-III

Course: Mathematical Physics-II (Differential Equations and Calculus of variation)			**Semester: III**
Course Code: BPHT 2101	**L T P**	**3 1 0**	**Credits: 4**

Objectives: To familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical physics. In addition, this course is intended to prepare the student with mathematical tools and techniques that are required in advanced courses offered in the applied physics and engineering programs.

Differential Equations 10

Classification: Ordinary and Partial, Order and Degree, Linear and Nonlinear, Homogeneous and Non-homogeneous. Solution: Explicit and Implicit, Number of Arbitrary Constants.
*Linear Ordinary Differential Equations***:** First order:- (1) Separable Equations. Initial Value Problem. (2) Exact Equations. Integrating Factor. (3) Linear Equations. Lagrange's Method of Variation of Parameters.

Second order 16

Homogeneous Equations with Constant Coefficients. Wronskian and General Solution. Statement of Existence and Uniqueness Theorem for Initial Value Problems. Solution of Non-homogeneous Equations by D Operator Method. Particular Integral. Methods of Undetermined Coefficients and Variation of Parameters. Equations Reducible to those with Constant Coefficients. Bernoulli and Euler Equations.

Coupled Differential Equations 2

Solution by Method of Elimination.

Calculus of Variations 20

Variational Principle. Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized Coordinates. Definition of Canonical Momenta. Euler-Lagrange's Equations of Motion and its Applications to Simple Problems: (e.g., simple pendulum and one dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force.: Definition of Hamiltonian (Legendre Transformation). Hamilton's Principle. Poisson Brackets and their Properties. Lagrange Brackets and their Properties.
Constrained Maxima and Minima. Lagrange's Method of Undetermined Multipliers and its Application to Simple Problems in Physics.

Suggested Readings

1. George B. Arfken, Hans J. Weber, Frank E. Harris, *Mathematical Methods for Physicists: A Comprehensive Guide*, 7 edition, Academic Press (2011).
2. B. D. Gupta, *Mathematical physics*, Viskas Pub, (1987).
3. Murray Spiegel, Seymour Lipschutz, *Schaum's Outline of Vector Analysis*, 2nd Edn., McGraw-Hill (2009).
4. Satya Prakash, *Mathematical physics*, Pragati Prakashan (2015).
5. H. K. Dass, R. Verma, M*athematical physics*, S Chand (2010).
6. B S Grewal, *Higher Engineering Mathematics*, Khanna Publishers (2000).

Course: Optics			Semester: III
Course Code: BPHT 2102	**L T P**	**3 0 0**	**Credits: 3**

Objective: To introduce students to relate theoretical concepts to real-world applications and experiments and to make them familiar with optics laboratory experiments and procedures. This course intends to develop an intuitive capability to research and to uncover the working principles of things that involve light.

Lenses 8

Transverse Magnification of a Spherically Refracting Surface. Lagrange and Helmholtz Laws of Magnification. Cardinal Points of a Coaxial Optical System. Graphical Construction of Image using Cardinal Points. Deviation produced by a Thin Lens. Equivalent Focal Length of Two Thin Lenses separated by a distance. Cardinal Points of a Coaxial System of Two Thin Lenses. Thick Lenses. Focal Length of a Thick Lens. Variation of Focal Length of a Convex Lens with Thickness. Cardinal Points of a Thick Lens. Optical aberrations in lenses.

Wave Optics

Nature of Light 3

Theories of Light. Electromagnetic Nature of Light Definition of a Wave Front. Propagation of a Wave Front. Huygens Principle of Secondary Wavelets.

Coherence 2

Temporal and Spatial Coherence. Theory of Partial Coherence. Coherence Time and Coherence Length. Purity of a Spectrum Line.

Interference 15

Interference: Division of Amplitude and Division of Wavefront. Young's Double Slit Experiment. Lloyd's Mirror and Fresnel's Biprism. Phase Change on Reflection: Stoke's treatment. Interference in Thin Films: Parallel and Wedge-shaped Films. Fringes of Equal Inclination (Haidinger Fringes) and Fringes of Equal Thickness (Fizeau Fringes). Newton's Rings: Measurement of Wavelength and Refractive Index. Michelson's Interferometer(1) Idea of form of fringes (No Theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, (5) Standardization of Meter and (6) Visibility of Fringes. Fabry-Perot interferometer

Diffraction 8

Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Fraunhofer diffraction 6

Diffraction due to (1) a Single Slit, (2) a Double Slit and (3) a Plane Transmission Grating. Rayleigh's criterion of resolution. Resolving Power and Dispersive Power of a Plane Diffraction Grating.

Polarization 6

Polarization by reflection and refraction, Brewster's law, double refraction, Nicol prism, quarter and half-wave plates, Production and analysis of circularly and elliptically polarized light.

Suggested Readings

1. Francis Arthur Jenkins and Harvey Elliott White, *Fundamentals of Optics*, Mc Graw-Hill (1976)
2. A. K. Ghatak, *Optics*, Tata McGraw-Hill Education (2005).
3. Abdul Al-Azzawi, *Light and Optics: Principles and Practices,* CRC Press, (2007).
4. A. K. Ghatak & K. Thyagarajan, *Contemporary Optics*, Plenum Press (1978).
5. Ashok Kumar, Dr Khanna, Hr Gulati, *Fundamentals of Optics*, R Chand & Co.

Course: Electricity and Magnetism			Semester: III
Course Code: BPHT 2103	**L T P**	**3 0 0**	**Credits: 3**

Objective: To provide key concepts of introductory electricity and magnetism from a standpoint of continually asking 'how do we know', addressing this using experimental evidence, conceptual logic, derivation, and application of equations.

Electric Field and Electric Potential

Electric Field 6

Electric Field and Lines. Electric Field **E** due to a Ring of Charge. Electric Flux. Gauss's law. Gauss's law in Differential form. Applications of Gauss's Law: **E** due to (1) an Infinite Line of Charge, (2) a Charged Cylindrical Conductor, (3) an Infinite Sheet of Charge and Two Parallel Charged Sheets, (4) a Charged Spherical Shell, (5) a Charged Conducting Sphere, (6) a Uniformly Charged Sphere, (7) Two Charged Concentric Spherical Shells and (8) a Charged Conductor. Force on the Surface of a Charged Conductor and Electrostatic Energy in the Medium surrounding a Charged Conductor.

Electric Potential 12

Line Integral of Electric Field. Electric Potential Difference and Electric Potential V (Line integral). Conservative Nature of Electrostatic Field. Relation between **E** and V. Electrostatic Potential Energy of a System of Charges. Potential and Electric Field of (1) a Dipole, (2) a Charged Wire and (3) a Charged Disc. Force and Torque on a Dipole. Conductors in an Electrostatic Field. Description of a System of Charged Conductors. An Isolated Conductor and Capacitance. Method of Images and its Application to:- (1) Plane Infinite Sheet and (2) Sphere. Electrostatic Energy of (1) a Point Charge, (2) a System of Point Charges, (3) a Uniform Sphere, (4) a Capacitor.

Dielectric Properties of Matter 6

Dielectrics

Electric Field in Matter. Dielectric Constant. Parallel Plate Capacitor with a Dielectric. Polarization, Polarization Charges and Polarization Vector. Electric Susceptibility. Gauss's law in Dielectrics. Displacement vector **D**. Relations between the three Electric Vectors. Capacitors filled with Dielectrics.

Magnetic Effect of Currents 8

Magnetic Field **B**. Magnetic Force between Current Elements and Definition of **B.** Magnetic Flux. Biot-Savart's Law : **B** due to (1) a Straight Current Carrying Conductor and (2) Current Loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital law (Integral and Differential Forms): B due to (1) a Solenoid and (2) a Toroid. Properties of **B.** Curl and Divergence of **B**. Vector Potential. Forces on an Isolated Moving Charge. Magnetic Force on a Current Carrying Wire. Torque on a Current Loop in a Uniform Magnetic Field.

Magnetic Properties of Matter 4

Magnetism of Matter: - Gauss's law of magnetism (Integral and Differential Forms). Magnetization current. Relative Permeability of a Material. Magnetic Susceptibility. Magnetization Vector (**M**). Magnetic Intensity (**H**). Relation between **B**, **M** and **H**. Stored Magnetic Energy in Matter. Magnetic Circuit. B-H Curve and Energy Loss in Hysteresis.

Electromagnetic induction 4

Faraday's law (Differential and Integral forms). Lenz's Law. Self and Mutual Induction. Energy stored in a Magnetic Field.

Ballistic Galvanometer 4

Potential Energy of a Current Loop. Ballistic Galvanometer: Current and Charge sensitivity. Electromagnetic Damping. Logarithmic Damping. CDR.

Suggested Readings

1. D C Tayal, *Electricity and Magnetism,* Himalaya Publishing House (1988).
2. Edward M. Purcell, *Electricity and Magnetism,* McGraw-Hill Education (1986).
3. Arthur F. Kip, *Fundamentals of Electricity and Magnetism,* McGraw-Hill (1968).
4. J.H.Fewkes & John Yarwood, *Electricity and Magnetism,* Vol. I, Oxford Univ. Press, (1991).
5. K. K. Tewari, *Electricity & Magnetism with Electronics*, S Chand & Company, (1995)

Course: Thermal Physics			Semester: III
Course Code: BPHT 2104	**L T P**	**3 0 0**	**Credits: 3**

Objective: To provide students with a solid understanding of the fundamental laws of thermodynamics, kinetic theory and statistical physics. This course also demonstrates some of the important applications of thermal physics in environmental and industrial contexts.

Thermodynamics 4

Zeroth and First Law of Thermodynamics, Thermodynamical Equilibrium. Zeroth Law of Thermodynamics and Concept of Temperature. Work and Heat Energy. State Functions. First Law of Thermodynamics. Differential form of First Law. Internal Energy. First Law and Various Processes. Applications of First Law : General Relation between Cp and Cv. Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficient. Atmosphere and Adiabatic Lapse Rate.

Second Law of Thermodynamics 8

Reversible and Irreversible Changes. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot Cycle. Carnot Engine and its Efficiency. Refrigerator and its Efficiency. Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy 6

Change in Entropy. Entropy of a State. Clausius Theorem. Clausius Inequality. Second Law of Thermodynamics in terms of Entropy. Entropy of a Perfect Gas. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Impossibility of Attainability of Absolute Zero : Third Law of Thermodynamics. Temperature-Entropy Diagrams. First and second order Phase Transitions.

Thermodynamic Potentials 6

Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials U, H, F and G Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work. Cooling due to Adiabatic Memagnetization. Approach to Absolute Zero.

Maxwell's Thermodynamic Relations 6

Derivations of Maxwell's Relations. Applications of Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) Tds Equations, (4) Joule-Kelvin Coefficient for Ideal and Van der Waal Gases, (5) Energy Equations and (6) Change of Temperature during an Adiabatic Process.

Kinetic Theory of Gases6 Lectures) 6

Distribution of Velocities :- Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.

Molecular Collisions 4

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Real gases 8

Behavior of Real Gases:- Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Suggested Readings

1. Enrico Fermi, *Thermodynamics*, Courier Dover Publications (1956).
2. Meghnad Saha, B. N. Srivastava, *A Treatise on Heat: Including Kinetic Theory of Gases, Thermodynamics and Recent Advances in Statistical Thermodynamics*, Indian Press (1958).
3. Mark Waldo Zemansky, Richard Dittman, *Heat and Thermodynamics: An Intermediate Textbook*, McGraw-Hill (1981).
4. Garg, Bansal and Ghosh, *Thermal Physics,* Tata McGra-Hill (1993).
5. Francis W. Sears & Gerhard L. Salinger, *Thermodynamics, Kinetic Theory, and Statistical Thermodynamics*, Narosa (1986).

Course: Quantum Mechanics			Semester: III
Course Code: BPHT 2105	**L T P**	**3 0 0**	**Credits: 3**

Objective: To provide students the historical development of quantum mechanics with previous knowledge, understand the differences between classical and quantum mechanics and learn the basic properties of quantum world.

Particles and Waves 20

Inadequacies in Classical Physics. Blackbody Radiation: Quantum Theory of Light. Photoelectric Effect. Compton Effect. Franck-Hertz experiment. Wave Nature of Matter : De Broglie Hypothesis. Wave-Particle Duality. Davisson-Germer Experiment. Wave description of Particles by Wave Packets. Group and Phase Velocities and Relation between them. Two-Slit Experiment with Electrons. Probability. Wave Amplitude and Wave Functions. Heisenberg's Uncertainty Principle (Uncertainty Relations involving Canonical Pair of Variables): Derivation from Wave Packets. γ-ray Microscope.

Quantum Mechanics 8

Basic Postulates and Formalism: - Energy, Momentum and Hamiltonian Operators. Time-independent Schrödinger Wave Equation for Stationary States. Properties of Wave Function. Interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Expectation Values. Wave Function of a Free Particle.

Applications of Schrödinger Wave Equation 12

Eigen Functions and Eigenvalues for a Particle in a One-Dimensional Box. Bound State Problems: - General Features of a Bound Particle System, (1) One Dimensional Simple Harmonic Oscillator: Energy Levels and Wave Functions. Zero Point Energy, (2) Quantum Theory of Hydrogen Atom: Particle in a Spherically Symmetric Potential. Schrodinger Equation. Separation of Variables. Radial Solutions and Principal Quantum Number, Orbital and Magnetic Quantum Numbers. Quantization of Energy and Angular Momentum. Space Quantization. Electron Probability Density. Radiative Transitions. Selection Rules.

Scattering Problems in One Dimension 6

(1) Finite Potential Step: Reflection and Transmission. Stationary Solutions. Probability Current. Attractive and Repulsive Potential Barriers. (2) Quantum Phenomenon of Tunnelling: Tunnel Effect. Tunnel Diode (Qualitative Description). (3) Finite Potential Well (Square Well).

Suggested Readings

1. L. I. Schiff, *Quantum Mechanics*, 3rd edition, McGraw Hill Book Co., New York (1968).
2. E. Merzbacher, *Quantum Mechanics*, 3rd edition, John Wiley & Sons Inc. (1997).
3. J.L. Powell & B. Crasemann, *Quantum Mechanics*, Addison-Wesley Pubs.Co. (1965).
4. A. Ghatak & S. Lokanathan, *Quantum Mechanics: Theory and Applications*, 5th Edition, Macmillan India, (2004).
5. David J. Griffith, *Introduction to Quantum Mechanics*, Pearson Education (2005).
6. Arno Bohm, *Quantum Mechanics: Foundations and Applications*, 3rd ed., Springer-Verlag, New York (2003).

Course: Solid State Physics			Semester: III
Course Code: BPHT 2106	**L T P**	**3 0 0**	**Credits: 3**

Objective: To provide students the basic understanding of symmetry, electronic and thermodynamic properties of solid state systems and their technological applications.

Crystal Structure 8

Solids:- Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Types of Bonds. Ionic Bond. Covalent Bond. Van der Waals Bond. Diffraction of x-rays by Crystals. Bragg's Law.

Elementary Lattice Dynamics 6

Lattice Vibrations and Phonons: - Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Einstein and Debye Theories of Specific Heat of Solids. *T3* Law.

Magnetic Properties of Matter 8

Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials 6

Polarization. Local Electric Field at an Atom. Depolarization Field. Dielectric Constant. Electric Susceptibility. Polarizability. Classical Theory of Electric Polarizability. Clausius-Mosotti Equation. Normal and Anomalous Dispersion. Complex Dielectric Constant.

Electrical Properties of Materials 10

Elementary Band Theory of Solids. Bloch Theorm. Kronig-Penney Model. Effective Mass of Electron. Concept of Holes. Band Gaps. Energy Band Diagram and Classification of Solids. Law of Mass Action. Insulators, and Semiconductors. Direct and Indirect Band Gap. Intrinsic and Extrinsic Semiconductors. p- and n- Type Semiconductors. Conductivity in Semiconductors. Hall Effect in Semiconductors (Qualitative Discussion Only)

Superconductivity 10

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation): Cooper Pair and Coherence length. Variation of Superconducting Energy Gap with Temperature. Experimental Evidence of Phonons. Josephson Effect.

Suggested Readings

1. Charles Kittel, *Introduction to Solid State Physics*, 8th Edition, John Wiley and Sons, Inc. (2012)
2. J. S. Blackmore, *Solid State Physics*, Cambridge University Press, Cambridge.
3. N. W. Ascroft and N. D. Mermin, *Solid State Physics*, Harcourt Asia, Singapore (2003).
4. M. Ali Omar, *Elementary solid state physics: principles and applications*, Pearson Education (1999).
5. A J Dekkar, *Solid State Physics*, Macmillan India Limited, (2000).

Course: Optics Lab			Semester: III
Course Code: BPHL 2101	**L T P**	**0 0 4**	**Credits: 2**

Objective: To instruct the students about optical instruments formed from multiple optical elements: periscopes, compound microscopes, prism, laser, refracting telescopes and reflecting telescopes.

List of Experiments:

1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine Dispersive Power of the Material of a given Prism using Mercury Light
3. To determine the value of Cauchy Constants of a material of a prism.
4. To determine the Resolving Power of a Prism.
5. To determine wavelength of sodium light using Fresnel Biprism.
6. To determine wavelength of sodium light using Newton's Rings.
7. To determine the wavelength of Laser light using Diffraction of Single Slit.
8. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
9. To determine the Resolving Power of a Plane Diffraction Grating.
10. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Suggested Readings

1. B.L. Flint & H.T. Worsnop, *Advanced Practical Physics for students*, Asia Publishing House. (1971).
2. Michael Nelson and Jon M. Ogborn, *Advanced level Physics Practicals*, 4th Edition, Heinemann Educational Publishers (1985).
3. Indu Prakash and Ramakrishna, *A Text Book of Practical Physics*, 11th Edition, Kitab Mahal, New Delhi. (2011).
6. M. Ali Omar, *Elementary solid state physics: principles and applications*, Pearson Education (1999).
7. A J Dekkar, *Solid State Physics*, Macmillan India Limited, (2000).

Semester-IV

Course: Mathematical Physics-III (Complex Analysis and Special functions)			**Semester: IV**
Course Code: BPHT 2201	**L T P**	**3 1 0**	**Credits: 4**

Objective: To allow student to review undergraduate level mathematics which are important to physics. To introduce students the topics (linear algebra, Fourier transform, differential equations, complex analysis, and special functions) which are important mathematical basics for graduate studies in theoretical physics.

Complex Variables 18

Importance of Complex Numbers and their Graphical Representation. De-Moivre's Theorem. Roots of Complex Numbers. Euler's Formula. Functions of Complex Variables. Examples. Cauchy-Riemann Conditions. Analytic Functions. Singularities. Differentiation and Integral Formula. Morera's Theorem, Cauchy's Inequality. Liouville's Theorem. Fundamental Theorem of Algebra. Multiple Valued Functions. Simple Ideas of Branch Points and Riemann Surfaces.

Power Series of a Complex Variable 8

Taylor and Laurent Series. Residue and Residue Theorem. Contour Integration and its Applications to Evaluation of Integrals.

Second Order Differential Equations and Special Functions 22

Series Solution of Linear Second Order Ordinary Differential Equations: Singular Points of Second Order Differential Equations and their Importance. Series Methods (Frobenius). Legendre, Bessel, Hermite and Laguerre Differential Equations. Legendre, Hermite and Laguerre Polynomials: Rodrigues' Formulae, Generating Functions, Recurrence Relations, Orthogonality. Series Expansion of a Function in terms of a Complete Set of Legendre Functions. Bessel Functions: First and Second Kind, Generating Function, Recurrence Formulas, Zeros of Bessel Functions and Orthogonality.

Suggested Readings

1. George B. Arfken, Hans J. Weber, Frank E. Harris, *Mathematical Methods for Physicists: A Comprehensive Guide*, 7 edition, Academic Press (2011).
2. B. D. Gupta, *Mathematical physics*, Viskas Pub, (1987).
3. Murray Spiegel, Seymour Lipschutz, *Schaum's Outline of Vector Analysis*, 2nd Edn., McGraw-Hill (2009).
4. Satya Prakash, *Mathematical physics*, Pragati Prakashan (2015).
5. H. K. Dass, R. Verma, M*athematical physics*, S Chand (2010).
6. B S Grewal, *Higher Engineering Mathematics*, Khanna Publishers (2000)

Course: Electronic Devices			Semester: IV
Course Code: BPHT 2202	**L T P**	**3 0 0**	**Credits: 3**

Objective: To make the students well versed with basic electronic components and circuits. This course introduces students to understand the nature and scope of modern electronics, design and construct simple electronic circuits to accomplish a specific function, e.g., designing amplifiers, ADC converters etc..

Circuit Analysis 6

Kirchhoff's Laws, Mesh and Node Analysis of dc and ac Circuits, Duality in Networks, Equivalent Star (T) and delta (π) Networks of a Given Network, Star to Delta and Delta to Star Conversion. Wheatstone Bridge and its Applications to Wein Bridge and Anderson Bridge.

Semiconductor Diodes 5

p and n Type Semiconductors. Energy Level Diagram. Conductivity and Mobility. pn Junction Fabrication (Simple Idea). Barrier Formation in pn Junction Diode. Current Flow Mechanism in Forward and Reverse Biased Diode (Recombination, Drift and Saturation of Drift Velocity). Derivation of Mathematical Equations for Barrier Potential, Barrier Width and Current for Step Junction. pn junction and its characteristics. Static and Dynamic Resistance. Diode Equivalent Circuit. Ideal Diode. Load Line Analysis of Diodes. Load Line and Q-point.

Bipolar Junction transistors 6

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α, β and γ and Relations between them. Load Line Analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff, and Saturation Regions. Transistor in Active Region and Equivalent Circuit.

Two-terminal Devices and their Applications 4

(1) Rectifier Diode. Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency. Qualitative idea of C, L and π - Filters. (2) Zener Diode and Voltage Regulation. (3) Photo Diode, (4) Tunnel Diode, (5) LED (6) Varactor Diode.

Amplifiers 8

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Resistance, Voltage and Power Gains. Class A, B, and C Amplifiers.

Coupled Amplifiers 5

RC-Coupled Amplifier and its Frequency Response of Voltage Gain. Feedback in Amplifiers, Effects of Positive and Negative Feedback on Input Impedance, Output Impedance and Gain, Stability, Distortion and Noise. Transformer coupled amplifier.

Three-terminal Devices (UJT and FETs) 4

(1) UJT:Its Chararacteristics and Equivalent Circuit. Relaxation Oscillator, (2) JEFT : Its Characteristics and Equivalent Circuit. Advantages of JFET. MOSFET (Qualtiative Discussion only).

Modulation and Demodulation 4

Types of Modulation. Amplitude Modulation. Modulation Index. Analysis of Amplitude Modulated Wave. Sideband Frequencies in AM Wave. CE Amplitude Modulator. Demodulation of AM Wave using Diode Detector. Idea of Frequency, Phase, and Digital Modulation.

Suggested Readings

1. Robert Boylestad, Louis Nashelsky, *Electronic Devices and Circuit Theory*, 8Th Edition, Pearson Education, India (2004).
2. A. P. Malvino, *Electronic Principals*, Glencoe (1993).
3. Allen Mottershead, *Electronic Circuits and Devices*, PHI (1997).
4. Ben G. Streetman & Sanjay Banerjee, *Solid state electronic devices*, Pearson Prentice Hall (2006).
5. N. N. Bhargava, D. C. Kulshreshtha & SC Gupta, *Basic Electronics & Linear Circuits*, Tata McGrawHill (2006).
6. John Morris, *Analog Electronics*, 2 edition, A Butterworth-Heinemann Title (1999).

Course: Electrical Circuits & Networks			Semester: IV
Course Code: BPHT 2203	**L T P**	**3 0 0**	**Credits: 3**

Objective: To understand the concept of circuit elements lumped circuits, waveforms, circuit laws and network reduction. The emphasis of this course is laid on the basic analysis of circuits which includes Theorems for AC, Three phase circuits, Transient analysis, Laplace transforms, network topology and Fourier series and transforms.

Electric Circuits 4

AC Circuits :- Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Network Theorems 16

Ideal Constant-voltage and Constant-current Sources. Network Theorems: (1) Thevenin theorem, (2) Norton theorem, (3) Superposition theorem, (4) Reciprocity theorem, and (5) Maximum Power Transfer theorem. Superposition theorem, maximum power transfer theorem, reciprocity theorem, Millman's theorem, substitution theorem, compensation theorem, Tellegen's theorem, all theorems using examples of AC networks.

*Two port network***:** One port and two port network, Sign convention, Admittance Parameter, Parallel connection of two port network, Impedance parameter, Series connection of two-port network. Hybrid parameters, Inverse Hybrid parameters, Transmission parameters, Inverse Transmission parameters, Concept of driving point impedance and admittance, Symmetrical two ports and bisection, Image impedance.

Magnetically coupled circuit 8

Mutual inductance, Coupling Co-efficient K, Dot rule for coupled coils, Analysis of coupled circuits, The T-equivalent network of the transformer.

Graph Theory: Graph of a network, Trees, Co-trees, Loops, Incidence matrix, cut-set matrix, Ties matrix and loop currents, Number of possible trees of a Graph, Analysis of Net works, Network Equilibrium Equation, Duality, General network transformation.

Application of Laplace Transform 5

Brief review of Laplace transform technique, Initial and final value Theorem, Solution of circuit transient using Laplace transform. Use of Laplace's transform in electrical circuit analysis.

Frequency Response 12

Concept of complex frequency, The complex frequency plane, Concept of Pole and Zero, Plot of Poles and Zeros of simple RL, RC and RLC circuit connected in series and parallel, polar plot, Concept of resonance, series and parallel resonance, Q factor, half power frequency, Concept of transfer function of a network.

*Fourier Analysis***:** Trigonometric Fourier Series, Evaluation of Fourier Coefficients, Waveform Symmetry, Exponential form, Fourier transform techniques applied in networks.

Filter Circuits 8

Classification of filters, equation of an ideal filter, Theory of pie section, Constant K-type filters, low pass filters, design of low pass filter, high pass filters, band pass filters, band rejection filters and all pass filters. M derived filters, theory of M-derived filters, M-derives low pass and high pass filters. Approximation theory of filters (Butter worth and Chebyshev).

Suggested Readings

1. Hayt & Kemmerly, *Engineering Circuit Analysis*, Mc Graw Hill (2012).
2. Roy Choudhury, *Network and Systems*, New Age (1988).
3. Rajeswaran, *Electric Circuit theory*, Pearson (2004).
4. Wadhwa, *Network Analysis and Synthesis*, 2nd edition, New Age (2006).
5. Soni & Gupta, *A Course in Electrical Circuit Analysis*, Dhanpat Rai & Sons
6. Van Valkenburg, *Network Analysis and Synthesis*, TMH (2006).

Course: Numerical Analysis			Semester: IV
Course Code: BMAT 2201	**L T P**	**3 0 0**	**Credits: 3**

Objective: To learn about existence and uniqueness criteria for numerical methods, to learn about convergences criteria and to be aware of reasons why numerical methods may fail.

Errors and Iterative Methods 3
Truncation and Round-off Errors. Floating Point Computation. Overflow and Underflow. Single and Double Precision Arithmetic. Iterative Methods.

Solution of Algebraic and Transcendental Equations 5
(1) Fixed-Point Iteration Method, (2) Bisection Method, (3) Secant Method, (4) Newton-Raphson Method, and (5) Generalized Newton's Method. Comparison and Error Estimation.

Matrices and Linear System of Equations 5
Solution of Linear Equations:- (1) Gauss Elimination Method and (2) Gauss-Seidel Iterative Method. Eigenvalues and Eigen vectors :- Computation of Eigenvalues and Eigenvectors of Matrices by using Iterative Methods.

Interpolation 4
Forward and Backward Differences. Symbolic Relation. Differences of a Polynomial. Newton' Forward and Backward Interpolation Formulas. Divided Differences. Newton's General Interpolation Formula.

Curve Fitting, B-Splines and Approximation 8
Curve Fitting by Least Square Methods: (1) Fitting a Straight Line. (2) Non-Linear Curve Fitting : (a) Power Function, (b) Polynomial of nth Degree, and (c) Exponential Function. (3) Linear Weighed Least Square Approximation. Orthogonal Polynomials. Gram-Schmidt Orthogonalization Process. Cubic B-Splines. Least-Squares Solution. Representation of B-Splines through Divided Differences. Approximation of Functions. Chebyshev Polynomials.

Numerical Differentiation 4
Numerical Differentiation using (1) Newton's Interpolation Formulas and (2) Cubic Spline Method. Errors in Numeric Differentiation. Maximum and Minimum Values of a Tabulated Function.

Numerical Integration 7
General Quadrature Formula. Trapezoidal Rule. Simpson's 1/3 and 3/8 Rules. Weddle's Rule. Gauss Quadrature Formulas: (1) Gauss- Hermite and (2) Gauss-Legendre Formulas.

Solution of Ordinary Differential Equations (ODE's) 8
First Order ODEs :- Solution of Initial Value Problems : (1) Euler's Method, (2) Modified Eulers's Method, (3) Runge-Kutta Method of Second Order with Error Estimation.
Second Order ODEs: Solution of 2-Point Boundary Value Problems. Finite Difference Approximation of Derivatives. Finite Differnce Method.

Suggested Readings
1. S.S. Sastry, *Introductory Methods of Numerical Analysis* 4th Ed., PHI Learning Pvt. Ltd. (2006).
2. James D. Scarborough, *Numerical Mathematical Analysis*, 6th edition, Oxford & IBH

Publishing.
3. Kendall E. Atkinson, *Elementary Numerical Analysis*, Wiley (1985).
4. Richard Wesley Hamming, *Numerical Methods for Scientists and Engineers*, Courier Dover Publications (1986).
5. *Schaum's Outline of Programming with C++*, 2nd Edition, McGraw-Hill;
6. William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, *Numerical Recipes in C++: The Art of Scientific Computing*, 2nd Edition. Cambridge University Press (2007).

Course: Electronics Device Lab			Semester: IV
Course Code: BPHL 2201	**L T P**	**0 0 4**	**Credits: 2**

Objective: To provide basic knowledge to plan, execute and report the results of an electronics experiment using electronic devices. This course also links the appropriate methods to analyze data and to evaluate the level of its uncertainty.

List of practicals

1. Characteristics of PN junction and Zener diode.
2. Input, Output and Transfer characteristics of CE and CC Amplifier.
3. Characteristics of LDR, Photo-diode and Photo transistor.
4. Transfer characteristics of JFET.
5. Transfer characteristics of MOSFET (with depletion and enhancement mode)
6. Characteristics of LED with three different wavelengths.
7. Half wave rectifier.
8. Full wave rectifier with 2 diodes.
9. Full wave rectifier with 4 diodes (Bridge rectifier).
10. Series voltage Regulator.
11. Shunt voltage Regulator.
12. Characteristics of Thermistor.
13. Simulation experiments using PSPICE or Multisim.

Suggested Readings

1. Paul B Zbar and Alber P Malvino, Michael A Miller, *Basic Electronics: A Text Lab Manual*, 7th edition, Tata McGraw Hill (2009).
2. David A Bell, *Laboratory Manual for Electronic Devices and Circuits*, 4th edition, PHI (2001)
3. Muhammed H Rashid, *SPICE for circuits and electronics using PSPICE*, 2nd edition, PHI (1995).
4. Mithal. G.K, *Practicals in Basic Electronics*, G K Publishers Private Limited (1997).
5. Maheswari. L.K and Anand.M.M.S, *Laboratory Manual for Introductory Electronic Experiments*, New Age (2010).
6. S. PoornachandraRao and B. Sasikala, *Handbook of Experiments in Electronics and Communication Engineering*, Vikas publishers (2003).

Course: Numerical Analysis Lab			Semester: IV
Course Code: BMAL 2201	**L T P**	**0 0 4**	**Credits: 2**

Objective: To train students to understand why the methods work, what type of errors to expect, and when an application might lead to difficulties. It also includes understanding the theoretical and practical aspects of the use of numerical methods.

List of Practicals

1: Algebraic & Transcendental Equations

i. To find the Roots of an Algebraic Equation by Bisection Method.
ii. To find the Roots of an Algebraic Equation by Secant Method.
iii. To find the Roots of an Algebraic Equation by Newton-Raphson Method.
iv. To find the Roots of a Transcendental Equation by Newton-Raphson Method .

2: Linear Equations & Eigenvalue Problem

i. To find the Roots of Linear Equations by Gauss Elimination Method.
ii. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
iii. To find the Eigenvalue and Eigenvector of a Matrix by Iterative Method.

3: Interpolation

i. To form a Forward Difference Table from a Given set of Data Values.
ii. To form a Backward Difference Table from a Given Set of Data Values.
iii. To find the value of y near the beginning of a Table of values of (x, y).
iv. To find the value of y near the end of a Table of values of (x, y).

4: Curve Fitting, B-Splines & Approximation

i. To fit a Straight Line to a given Set of Data Values.
ii. To fit a Polynomial to a given Set of Data Values.
iii. To fit an Exponential Function to a given Set of Data Values.
iv. To fit a natural Cubic B-Spline to a given Data.

5: Differentiation

i. To find the First and Second Derivatives near the beginning of a Table of values of (x, y).
ii. To find the First and Second Derivatives near the end of a Table of values of (x, y).

6: Integration

i. To evaluate a Definite Integral by Trapezoidal Rule.
ii. To evaluate a Definite Integral by Simpson's 1/3 Rule.
iii. To evaluate a Definite Integral by Simpson's 3/8 Rule.
iv. To evaluate a Definite Integral by Gauss Quadrature Formula.

7: Differential Equations

i. To solve a Differential Equation by Euler's Method.
ii. To solve a Differential Equation by Modified Euler's Method.
iii. To solve a Differential Equation by Second Order Runge Kutta Method.
iv. To solve a Differential Equation by Fourth Order Runge Kutta Method.

Note

i. The above Problems are to be programmed in C/C++.
ii. The above Problems can also be solved by using appropriate computer softwares.
iii. Each Student is required to write and run at least 14 Programs by taking at least 2

iv. Problems from each of the units from 405.1 to 405.7.

Suggested Readings

1. S.S. Sastry, *Introductory Methods of Numerical Analysis*, 4th Ed., PHI Learning Pvt. Ltd., (2006)
2. James D. Scarborough, *Numerical Mathematical Analysis* 6th Edition, Oxford & IBH Publishing
3. Kendall E. Atkinson, *Elementary Numerical Analysis*, Wiley (1985).
4. Richard Wesley Hamming, *Numerical Methods for Scientists and Engineers,* Courier Dover Publications (1986).
5. Schaum's Outline of *Programming with C++*,2nd edition, McGraw-Hill.
6. William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, *Numerical Recipes in C++: The Art of Scientific Computing*, 2nd Edition. Cambridge University Press (2007).

Semester-V

Course: Mathematical Physics IV (Linear Algebra and partial Differential Equation)			**Semester: V**
Course Code: BPHT 3101	**L T P**	**3 1 0**	**Credits: 4**

Objective: To provide students the fundamental knowledge of mathematics which can be used to solve the problems in the branches of physics. This course introduces the application of abstract algebra, calculus and geometry to systematically solve the equations which appear in the various branches of physics

Linear Vector Spaces 9

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices.

Matrices 15

Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Adjoint of a Matrix. Inverse of a Matrix by Adjoint Method. Similarity Transformations. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product.

Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Bilinear and Quadratic Forms. Functions of a Matrix.

Partial Differential Equations 24

General Solution of Wave Equation in 1 Dimension. Transverse Vibrations of Stretched Strings. Oscillations of Hanging Chain. Wave Equation in 2 and 3 Dimensions. Vibrations of Rectangular and Circular Membranes.

Heat Flow in One, Two, and Three Dimensions. Heat Flow in Rectangular Systems of Finite Boundaries. Temperature inside Circular Plate. Laplace Equation in Cartesian, Cylindrical and Spherical Coordinate Systems. Problems of Steady Flow of Heat in Rectangular and Circular Plate.

Suggested Readings

1. Matrices and Tensors in Physics by A.W.Joshi.(New Age Int.Pub., 1995).
2. Linear Algebra Theory and Applications by Ward Cheney and David Kincaid (Jones & Bartlett)
3. Vector Spaces and Matrices in Physics by M. C. Jain (Alpha Science International Ltd, 2007).
4. Partial Differential Equations for Scientists and Engineers By Stanley J. Farlow (Dover Publishers, 1993).
5. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Limited,1985)
6. A Text Book of Differential Equations By N. M. Kapoor (Pitambar Publishing, 2006).
7. Methods of Mathematical Physics: Partial Differential Equations by R.Courant & D.Hilbert.(New Delhi: Wiley India, 2008).

Course: Digital Electronics			Semester: V
Course Code: BPHT 3102	**L T P**	**3 0 0**	**Credits: 3**

Objective: To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. To introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions. To prepare students to perform the analysis and design of various digital electronic circuits.

Analog Circuits 18

Integrated Circuits (Qualitative Treatment only) :- Active and Passive components. Discrete Circuit Component. Wafer. Chip. Advantages and Drawbacks of ICs. Scale of integration : SSI, MSI, LSI and VLSI (Basic Idea and Definitions Only). Classification of ICs. Fabrication of Components on Monolithic ICs. Examples of Linear and Digital ICs.

Operational Amplifiers (Use Black Box approach): Basic Characteristics of Op-Amps. Characteristics of an Ideal Op-Amp. Feedback in Amplifiers. Open-loop and Closed-loop Gain. Frequency Response. CMRR. Virtual ground.

Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Unity follower, (5) Differentiator, (6) Integrator, (7) Zero Crossing Detector.

*Timers (Use Black Box approach)***:** 555 Timer and its Applications : Astable and Monostable Multivibrator.

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Digital Circuits 20

Difference Between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND AND NOR Gates. Exclusive OR and Exclusive NOR Gates.

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors (only up to Eight Bits).

*Data processing circuits***:** Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders, Parity Checkers.

Memories: Read-only memories (ROM), PROM, EPROM, RAM

Sequential Circuits: RS, D, and JK Flip-Flops. Level Clocked and Edge Triggered Flip-Flops. Preset and Clear Operations. Race-around Conditions in JK Flip-Flops. Master-Slave JK Flip- Flop (As Building Block of Sequential Circuits).

*Shift registers***:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out, and Parallel-in-Parallel-out Shift Registers (only upto 4 bits).

Counters: Asynchronous and Synchronous Counters. Ring Counters. Decade Counter.

D/A and A/D conversion: D/A converter – Resistive network. Accuracy and Resolution.

Suggested Readings

1. Donald P. Leach & Albert Paul Malvino, *Digital principles and applications*, Glencoe (1995).
2. Thomas L. Floyd, *Digital Fundamentals*, 3rd Edition Universal Book Stall, India (1998).
3. R. P. Jain, *Modern Digital Electronics*, 4th edition, McGraw Hill Education (2009).

4. Robert F Coughlin and Frederick F Driscoll, *Operational Amplifiers and Linear Integrated Circuits*, 4th Edition, P.H.I. (1992).
5. R. A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, Pearson Education Asia, (2000).

Course: Microprocessor and Computer Programming			Semester: V
Course Code: BMCT 3101	**L T P**	**3 0 0**	**Credits: 3**

Objective: To investigate the microprocessor with a comparative analysis of some popular forms; memory devices, interface and other support circuitry; assembly language and machine language programming; microprocessor use in dedicated applications. The course includes a laboratory devoted to software and hardware design.

Introduction 3

Hexadecimal Number System and Arithmetic. Computer Organization. Input / Output Devices. Data Storage. Computer Memory. Memory Organization and Addressing. Memory Interfacing. Memory Map.

Intel 8085 Microprocessor Architecture 12

Main Features of 8085. Block Diagram. Components. Pin-out Diagram. Buses. Registers. ALU. Memory. Stack Memory. Interfacing Devices. Timing and Control Circuitry. Timing States. Instruction Cycle (Timing Diagram). Interrupts and Interrupt Control. Input / Output.
8085 Instructions: Instructions. Machine Language. Assembly Language. Instruction Set and Format. Data Transfer, Arithmetic, Logical, Branching and Machine Control Operations. RIM and SIM. Addressing Modes : Register, Implied, Immediate, Direct and Indirect.

Microprocessor Programming 8

Algorithm and Flowcharts. Simple programming Exercises : Addition, Subtraction, Multiplication and Division - Both 8 and 16 bit etc.
C & C++ Programming Languages: Basic Components of Computer Systems. Types of Computer Systems. Types of Operating Systems.
Introduction to Programming: Algorithms: Sequence, Selection and Repetition. Structured Programming. Basic Idea of Compilers.

Data and Statements 12

Data Types. Enumerated Data. Conversion and Casting. Constants and Variables. Mathematical, Relational, Logical and Bitwise Operators. Precedence of Operators. Expressions and Statements. Scope and Visibility of Data. Block, Local and Global variables. Auto, Static and External Variables.
*I/O Statements***:** Printf, scanf, getc, getch, getchar, getche, etc. Streams: cin and cout. Manipulators for Data Formatting: setw, width, endl and setprecision etc. Ascii Files I/O.
Pre-processor: #include and #define directives.

Control Statements 15

If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-while Loop. For Loop. Break and Continue Statements. Nested Loops.
Arrays and Structures: One and Two Dimensional Arrays. Idea of Structures.
Functions: Standard Library Functions and User-defined Functions. Void Functions and Functions returning Values. Function Prototypes. Function Call by Value and by Reference. Recursion. Idea of Function Overloading.
*Idea of Classes, Objects and Inheritance***:** Classes and Objects. Member Functions in a class. Private and Public Qualifiers and Data Security. Constructors and Destructors. Inheritance. Idea of Strings and Pointers.

Suggested Readings

1. R.S. Goankar, *Microprocessor Architecture Programming and applications with 8085*, Prentice Hall. (2002).
2. A. Wadhwa, *Microprocessor 8085:Architecture, Programming and interfacing*, PHI Learning (2010).
3. Neill Graham, *Microprocessor programming for computer hobbyists,* ; 1st edition*, G/L Tab Books (1977)*.

Course: Atomic and Molecular Physics			Semester: V
Course Code: BPHT 3103	**L T P**	**3 0 0**	**Credits: 3**

Objectives: To introduce students to atomic and molecular physics with non-relativistic quantum mechanics and elementary mathematical physics as prerequisites. This course will help students to develop the skills to solve real physical problems using quantum mechanics

Introduction 8

Determination of e/m of the Electron. Thermionic Emission.

X-rays: Ionizing Power, X-ray Diffraction, Bragg's Law. Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law.

Atoms in Electric and Magnetic Fields 10

Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Many electron atoms 10

Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Molecular Spectra 15

Rotational Energy levels, Selection Rules and Pure Rotational Spectra of a Molecule. Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation- Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance.

*Raman Effect***:** Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stoke's and Anti-Stoke's Lines. Complimentary Character of Raman and infrared Spectra.

Lasers 4

Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

Suggested Readings

1. Raj Kumar, *Atomic and Molecular Spectra: Laser*, Kedarnath Ramnath, Meruth, Delhi (2012)

2. Arthur Beiser, *Concepts of Modern Physics*, McGraw-Hill Book Company, (1987)

3. Bransden and Joachein, *Physics of atoms and Molecules*, 2nd edition, Pearson Education India (2003).

4. Gordon W F Drake, Atomic, Molecular, and Optical Physics Handbook, American Institute of Physics (1996).

5. Gerhard Herzberg, *Atomic Spectra and Atomic Structure,* 2nd ed., Dover Publications; (2010).

Course: Laser Physics			Semester: V
Course Code: BPHT 3104	**L T P**	**3 0 0**	**Credits: 3**

Objective: To develop a working knowledge and conceptual understanding of important topics in contemporary laser physics at a quantitative level. A key objective is to enable the student to undertake quantitative problem-solving relating to the design, performance and applications of lasers.

Basic Laser Principle 10

Summary of black body radiation, Quantum theory for evaluation of the transition rates and Einstein coefficients-allowed and forbidden levels-metastable state; population inversion; rate equations for three level and four level lasers, threshold of power calculation, various broadening mechanism, homogeneous and inhomogeneous broadening.

Basic Laser System 5

Basic concept of construction of laser system, various pumping system, pumping cavities for solid state laser system, characteristics of host materials and doped ions.

Optical beam propagation 8

Paraxial ray analysis, wave analysis of beams and resonators, propagation and properties of Gaussian beam, Gaussian beam in lens like medium, ABCD law-Gaussian beam focusing.

Resonators 15

Stability of resonators-'g' parameter, various types of resonators, evaluation of beam waist of such combination, design aspect of resonator for various types of lasers, unstable resonator and their application.

*Q-switching***:** Giant pulse theory, different Q-switching techniques: mechanical Q-switching, electrooptic Q-switching, acousto-optic Q-switching, dye Q-switching, Raman-Nath effect.

Suggested Readings

1. Raj Kumar, *Atomic and Molecular Spectra: Laser*, Kedarnath Ramnath, Meruth, Delhi (2012).
2. W Koechner, *Solid State Laser Engineering,* Springer-Verlag Berlin Heidelberg (1999).
3. A Yariv, *Quantum Electronics*, 3rd edition, John Wiley & Sons (1988).
4. D R Hall & P E Jackson, *The Physics and Technology of Laser Resonator*, Taylor and Francis group, New York (1989).
5. O Svelto, *Principles of lasers*, Springer US (1989).

Course: Microprocessor and Computer Lab			Semester: V
Course Code: BMCL 3101	**L T P**	**0 0 4**	**Credits: 2**

Objective: To familiarize students with the architecture and the instruction set of an Intel microprocessor. This course also contains the concept of assembly language programming together with the design of various types of digital and analog interfaces. To provide practical hands-on experience with microprocessor software applications and interfacing techniques

A: Assembly Language Programming (using 8 bit processor)

1. Addition and Subtraction of Numbers using Direct Addressing Mode.
2. Addition and Subtraction of Numbers using Indirect Addressing Mode
3. Multiplication by Repeated Addition.
4. Division by Repeated Subtraction.
5. Handling of 16-bit Numbers.
6. Use of CALL and RETURN Instruction.
7. Block Data Handling.
8. Other Exercises (e.g. Parity Check etc.).

B: C & C++ Programming

1. To evaluate a Polynomial:- (1) Converting Temperature from Fahrenheit to Celsius, (2) Area of a Circle, (3) Volume of Sphere etc.
2. To find the Roots of a Quadratic Equation: Real and Distinct, Repeated and Imaginary.
3. To locate a Number in a Given List (linear search).
4. (i) To find the Largest of Three Numbers.
   (ii) To find the Largest Number in a Given List of Numbers.
5. (i) To check whether a Given Number is a Prime Number. (ii) To calculate the first 100 prime numbers.
6. To rearrange a List of Numbers in Ascending and Descending Order.
7. (i) To calculate Factorial of a Number. (ii) To calculate the first few Factorials.
8. Manipulation of Matrices
   (i) To Add and Subtract two Matrices. (ii) To Multiply two Matrices.

Suggested Readings

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, Prentice Hall (2002).
2. William A. Routt, *Microprocessor Architecture, Programming, and Systems featuring the 8085*, *Thomson Delmar Learning,* (2006).
3. Kenneth L Short, *Microprocessors and programmed Logic*, 2nd Edition P.H.I. (1988).
4. *Schaum's Outline of Programming with C++*, 2nd edition, McGraw-Hill;
5. *Numerical Recipes in C++: The Art of Scientific Computing*, 2nd Edition, Cambridge University Press;

Course: Digital Electronics Lab			Semester: V
Course Code: BPHL 3101	**L T P**	**0 0 4**	**Credits: 2**

Objective: To provide students basic experimental experiences in the operation of various families of digital circuits. To develop skills in the design of transistor-level digital circuits and simulate them in PSpice

Combinational Logic

i. To verify and design AND, OR, NOT and XOR gates using NAND gates.
ii. To design a combinational logic system for a specified Truth Table.
iii. To convert a Boolean Expression into Logic Gate Circuit and assemble it using logic gate ICs.
iv. To minimize a given Logic Circuit.

Decoders

i. To study TTL ICs of (a) Binary Decoder, (b) 7-segment Decoder, and (c) Schmit Trigger.
ii. To design a Seven-Segment Display driver.

Arithmetic and Logic Units (ALU)

i. Half Adder, Full Adder and 4-bit Binary Adder.
ii. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

Flip-Flops, Counters and Shift Registers

i. To build Flip-Flop Circuits using elementary gates (RS, Clocked RS, D-type, and JK Flip-Flop).
ii. To build a 4-bit Counter using D-type/JK Flip-Flop.
iii. To make a Shift Register from D-type/JK Flip-Flop.
iv. Serial and Parallel shifting of data.

Analog/Digital Conversion

i. To design an analog to digital converter of given specifications.
ii. To design a digital to analog converter of given specifications.

Op-Amp

i. To design an Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.
ii. To design a Non-Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.
iii. To design and study a precision Differential Amplifier of given I/O specification using Op-amp 741.

Timer

i. To design an Astable Multivibrator of given specifications using 555 Timer.
ii. To design a Monostable Multivibrator of given specifications using 555 Timer and to measure the Pulse-Width of its output.

Note

Each student is required to perform at least 8 Practicals from the above list.

Programs

(1) Roots of a Quadratic Equation, (2) Sum and Average of Numbers, (3) Sum, Difference and Product of Matrices, (4) Largest of Three Numbers, (5) Factorial of an Integer by Normal Method and by Recursion, (6) Largest of a List of Numbers and its Location in the List, (7) Fitting a Straight Line to a Data, (8) Deviations About an Average, (9) Arrange a List of Numbers in Ascending and Descending Order, (10) Binary Search.

Suggested Readings

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, Prentice Hall, (2002).
2. William A. Routt, *Microprocessor Architecture, Programming, and Systems featuring the 8085*, Thomson Delmar Learning, (2006).
3. Kenneth L Short, *Microprocessors and Programmed Logic*, 2nd Edition, P.H.I., (1988).
4. *Schaum's Outline of Programming with C++*, McGraw-Hill; 2nd Edition
5. *Numerical Recipes in C++: The Art of Scientific Computing*, 2 Edition, Cambridge University Press.

Semester VI

Course: Electromagnetic Theory			**Semester: VI**
Course Code: BPHT 3201	**L T P**	**3 0 0**	**Credits: 3**

Objective: To introduce students the fundamentals of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as fiber optics and electronic electromagnetic structures.

Maxwell's Equations 12

Maxwell Equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

Reflection and Refraction of Electromagnetic Waves 12

Reflection and Refraction of a Plane Wave at a Plane Interface between Dielectics. Fresnel Formulae. Total Internal Reflection. Brewster's Angle. Waves in Conducting Media. Metallic Reflection (Normal Incidence). Skin Depth. Maxwell's Equations in Microscopic Media (Plasma). Characteristic Plasma Frequency. Refractive Index. Conductivity of an Ionized Gas. Propagation of e.m. Waves in Ionosphere.

Polarization of Electromagnetic Waves 10

Description of Linear, Circular and Elliptical Polarization. Propagation of e.m. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary and Extraordinary Refractive Indices. Production and Detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

Rotatory Polarization 5

Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of Optical Rotation. Calculation of Angle of Rotation. Experimental Verification of Fresnel's Theory. Specific Rotation. Laurent's Half-Shade Polarimeter.

Wave Guides 6

Planar Optical Wave Guides. Planar Dielectric Wave Guide. Condition of Continuity at Interface. Phae Shift on Total Reflection. Einenvalue Equations. Phase and Group Velocity of the Guided Waves. Field Energy and Power Transmission.

Optical Fibres 3

Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Suggested Readings

1. A.Z.Capri & P.V.Panat, *Introduction to Electrodynamics,* Narosa Pub.House, (2002).

2. Joseph A.Edminister, *Electromagnetics*,2nd ed. Tata Mc Graw Hill, (2006).
3. M.A.W.Miah, *Fundamentals of electromagnetics* Tata Mc Graw Hill (1992).
4. Liang Chi Shen, Jin Au Kong, *Applied electromagnetism* PWS Pub. Co. (1995).
5. David J. Griffiths, *Introduction to Electrodynamics*, 3rd edition, Benjamin Cummings (1998).
6. J. D. Jackson, *Classical Electrodynamics*, 3rd edition, Wiley, New York (1998)

Course: Statistical Physics			Semester: VI
Course Code: BPHT 3202	**L T P**	**3 0 0**	**Credits: 3**

Objective: To develop concepts in classical laws of thermodynamics and their application, postulates of statistical mechanics, statistical interpretation of thermodynamics, microcanonical, canonical and grant canonical ensembles. The course also extends the application of statistics in the development of the statistics for Bose-Einstein, Fermi-Dirac and photon gases; selected topics from low temperature physics and electrical and thermal properties of matter are discussed.

Classical Statistics 16

Entropy and Thermodynamic Probability. Maxwell-Boltzmann Distribution Law. Ensemble Concept. Partition Function. Thermodynamic Functions of Finite Number of Energy Levels. Negative Temperature. Thermodynamic Functions of an Ideal Gas. Classical Entropy Expression, Gibbs Paradox. Law of Equipartition of Energy – Applications to Specific Heat and its Limitations.

Classical Theory of Radiation 5

Properties of Thermal Radiation. Blackbody Radiation. Pure Temperature Dependence. Kirchhoff's Law. Stefan-Boltzmann Law and Wien's Displacement law. Saha's Ionization Formula.

Quantum Theory of Radiation 10

Radiation:- Stefan-Boltzmann Law: Thermodynamic Proof. Radiation Pressure. Spectral Distribution of Black Body Radiation. Wien's Distribution Law and Displacement Law. Rayleigh-Jean's Law. Ultraviolet Catastrophe. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation : Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law and (4) Wien's Displacement Law from Planck's Law.

Bose-Einstein Statistics 8

B-E distribution law. Thermodynamic functions of a Completely Degenerate Bose Gas. Bose-Einstein condensation, properties of liquid He (qualitative description). Radiation as photon gas. Bose's derivation of Planck's law.

Fermi-Dirac Statistics 8

Fermi-Dirac Distribution Law. Thermodynamic functions of an ideal Completely Degenerate Fermi Gas. Fermi Energy. Electron gas in a Metal. Specific Heat of Metals. White Dwarf Stars. Chandrasekhar Mass Limit.

Suggested Readings

1. F Reif, Statistical Physics: Berkeley Physics Course Volume 5 Tata McGraw-Hill Company Ltd, (2008).
2. S.Lokanathan and R.S.Gambhir, *Statistical and Thermal Physics: an introduction*, P.H.I. (1991).
3. R. K. Patharia, *Statistical Mechanics*, Oxford: Butterworth, (1996).
4. K. Huang, *Statistical Mechanics*, Wiley, (1987).
5. Charles Kittel, *Elementary Statistical Physics*, Dover Publications (2004).

Course: Nuclear and Particle Physics			Semester: VI
Course Code: BPHT 3203	**L T P**	**3 0 0**	**Credits: 3**

Objective: To introduce students to the fundamental principles and concepts governing nuclear and particle physics and have a working knowledge of their application to real-life problems. This course also contains the concepts of nuclear-particle physics, including particle detectors and accelerators, experimental techniques, nuclear fission/fusion and associated reactors, medical applications, nuclear astrophysics and particle cosmology

Structure of nuclei 9

Basic Properties of Nuclei: (1) Mass, (2) Radii, (3) Charge, (4) Angular Momentum, (5) Spin, (5) Magnetic Moment (μ), (6) Stability and (7) Binding Energy. Semi empirical mass formula, magic numbers.

*Radioactivity***:** Law of Radioactive Decay. Half-life, Theory of Successive Radioactive Transformations. Radioactive Series, Binding Energy, Mass Formula.

α-decay: Range of α-particles, Geiger-Nuttal law and α-particle Spectra. Gamow Theory of Alpha Decay.

β-decay: Energy Spectra and Neutrino Hypothesis.

γ-decay: Origin of γ-rays, Nuclear Isomerism and Internal Conversion.

Nuclear Reactions 8

Types of Reactions and Conservation Laws. Concept of Compound and Direct Reaction. Compound Nucleus. Scattering Problem in One Dimension: Reflection and Transmission by a Finite Potential Step. Stationary Solutions, Attractive and Repulsive Potential Barriers. Scattering Cross-section. Reaction Rate. Q-value of Reaction. Fission and Fusion.

Nuclear Models 6

Liquid Drop Model. Mass formula. Shell Model.

Accelerators 4

Van de Graaff Generator, Linear Accelerator, Cyclotron, Betatron, and Light and Heavy Ion Synchro-Cyclotron. Idea of Large Hadron Collider.

Detectors of Nuclear Radiations 5

Interaction of Energetic particles with matter. Ionization chamber. GM Counter. Cloud Chambers. Wilson Cloud Chamber. Bubble Chamber. Scintillatipn Detectors. Semiconductor Detectors (Qualitative Discussion Only). An Idea about Detectors used in Large Hadron Collider.

Cosmic Rays 12

Nature and Properties.

*Elementary Particles (Qualitative Discussion Only)***:** Fundamental Interactions. Classification of Elementary Particles. Particles and Antiparticles. Baryons, Hyperons, Leptons, and Mesons. Elementary Particle Quantum Numbers: Baryon Number, Lepton Number, Strangeness, Electric Charge, Hypercharge and Isospin. Different Types of Quarks and Quark Contents of Spin ½ Baryons. Photons, Gravitons, Gluons, Charms and Intermediate Vector Bosons. Idea of Standard Model. Higg's Boson. Meson Theory of Nuclear Forces and Discovery of Pion.

Suggested Readings

1. Arthur Beiser, *Concepts of Modern Physics*, McGraw-Hill Book Company (1987).
2. Bernard L.Cohen, *Concepts of nuclear physics*, Tata Mcgraw Hill (1998).

3. R.A. Dunlap, *Introduction to the physics of nuclei and particles,* Singapore: Thomson Asia (2004).
4. Irving Kaplan, *Nuclear physics*, Oxford & IBH (1962).
5. Kenneth S. Krane, *Introductory nuclear physics*, John Wiley & Sons (1988).

Course: Introduction to Nanoscience and Nanotechnology			Semester: VI
Course Code: BPHT 3204	**L T P**	**3 0 0**	**Credits: 3**

Objective: To introduce students to the underlying principles and applications of the emerging field of nanotechnology and nanoscience. The course introduces tools and principles relevant at the nanoscale dimension, discusses current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics and energy.

Fundamental concepts 15

Concept of nanoscience and nanotechnology. The nanoscale. Impact of the nanotechnology in the society. Ethical, social, economic and environmental implications. -Nanotechnology in the history and in nature. Bioinspiration. Size dependent physical and chemical properties. Surface effects. Importance of the surface at nanoscale. The surface/volume ratio. Surface energy at solids. Surface reactivity and catalysis. Surface reconstruction and relaxation. Adsorption and electrical double layer effects. Surface tension in liquids, contact angles and capillary forces. -Size dependent properties: quantum effects. The classical theory vs. quantum theory. Black body radiation. Photoelectric effect. The atom Rutherford and Bohr. The electron as wave and particle. Wavefunction and uncertainty principle. Schroedinger equation. Particle in a box. Energy discretization and Confinement effect. Tunnel effect.

Nanomaterials 12

Graphene and carbon nanotubes: synthesis, properties and aplications. -Colloids and their properties. Metal, semiconductor and magnetic nanoparticles. Synthesis, properties and applications in sensors, catalysis and nano-medicine. Nanomaterials based on lipids, polymers and proteins: properties and applications. Smart materials: Stimuli responsive and self-healing nanomaterials. Molecular motors and switches. Concept of self-assembly, hierarchical organization. DNA and protein based supramolecular structures.

Characterization and Nanofabrication techniques 15

Techniques based on the interaction of electromagnetic radiation/materials. Synchrotron radiation. Characterization techniques based on the interaction of electrons/materials. Transmission electron Microscopy and Scanning electron Microscopy. Chemical Microanalysis. Practical demonstration in a microscope Scanning Electron. Visit to a transmission electron microscope. Scanning probes nanoscopies based on the interaction of a tip with a sample. Scanning Tunneling Microscopy and different modes of Atomic force Microscopy. Force spectroscopy. Nanofabrication techniques: top-down and bottom-up approach. Photolithography. Electron and ion beam lithography. Applications Lithography based on scanning tunneling microscopy and atomic force microscopy. Dip-pen nanolithography. Applications. Practice: visit of a cleanroom at the National Centre of Microelectronics, visit at the Catalan Institute of Nanotechnology

Suggested Readings

1. B. S. Murty et al. *Textbook of nanoscience and nanotechnology*. Springer Science & Business Media, (2013).
2. T. Pradeep, *A textbook of nanoscience and nanotechnology*. Tata McGraw-Hill Education, (2012).
3. Hornyak, L. Gabor, et al. *Introduction to nanoscience*. CRC press, (2008).
4. Wolf, L. Edward, Nanophysics *and nanotechnology: An introduction to modern concepts in nanoscience*. John Wiley & Sons (2015).
5. Schaefer, Hans-Eckhardt. *Nanoscience: the science of the small in physics, engineering,*

chemistry, biology and medicine. Springer Science & Business Media (2010).

Course: Material Science			Semester: VI
Course Code: BPHT 3205	**L T P**	**3 0 0**	**Credits: 3**

Objective: To introduce students the design, selection and processing of materials for a wide range of applications in engineering and elsewhere. The course will explain students how and why the properties of materials are controlled by structure and bonding at the atomic-scale, and by features at the microstructural and macroscopic levels.

Material Science 10

Classification of materials - Engineering requirements of materials - Material structure - Types of Bonds and their energies - Bond formation mechanism - Ionic bond - covalent bond examples ceramics - thermal and electrical properties - uses. Metallic bond - comparison of bonds [Dispersion bonds, Dipole bonds and Hydrogen bonds]. Crystal Imperfections - Types of imperfections - Thermal vibrations - point, line and surface imperfections - Frank - Read source.

Phase Diagrams 8

Basic terms - solid solutions - Hume - Rothery's rules - Intermediate phase - phase diagrams - Gibb's Phase rules - Time - Temperature cooling curves - construction of phase diagrams - the Lever rule - eutectic systems - eutecoid systems - peritectic and peritectoid systems Ternary equilibrium diagram.

Phase Transformation 8

Rate of transformation - Nucleation [Homogeneous, Heterogenous] - Nucleation and growth - Applications of Phase transformations - Micro constituent of iron - carbon system - The allotropy of iron- Iron - Carbon equilibrium diagram - formation of Austenite - TTT Diagram - transformation Austenite upon continuous cooling.

Electron theory of metals 8

Fundamental theories of electrons [Drude and Lorentz theory and Sommerfield free electron theory] - Electron energies in a metal - zone theory of solids - energy gaps - Density of states - zones in conductors, insulators and semi conductors - Factors affecting electrical resistance of materials.

Electrical and magnetic properties of materials 8

Resistivity - Conductivity - Semi conductors - classification of semi-conductors on the basis of Fermi energy and Fermi level - Insulators - Dielectrics - Ferro electricity - Electro striction - Piezoelectricity - uses of dielectrics - Capacitors Dielectric strength - Magnetic properties of classification - magneto striction - Magnetic Domain - Soft and Hard magnetic materials.

Suggested Readings

1. S. K. Hajra Choudhury, *Materials Science and processes in SI units*, Indian Book distributing company, (1977).
2. G.K. Narula; K.S. Narula; V.K. Gupta, *Materials Science*, Tata McGraw-Hill, (1989).
3. R.B. Gupta, *Material Science* AMIE Satya Prakashan New Delhi, (1980).

Course: Computer Programming Lab			Semester: VI
Course Code: BCPL 3201	**L T P**	**0 0 4**	**Credits: 2**

Objectives: To provide students an opportunity for learning and better understanding of the basic concepts and constructs of computer programming. This lab covers different concepts in C programming, like Numerical Approximation, Functions, Advanced Control Flow, Arrays, Structures, Basic Control Flow, Strings, Pointers, etc..

List of Practicals

1. Program to compute the compute the average.
2. Write a program to check whether a number is even or odd.
3. Write a program to check whether a number is prime number or not.
4. Write a program to check whether a year is leap year or not.
5. Write a program to find largest of three numbers.
6. Write a program to check whether a character is vowel or consonant using switch statement.
7. Write a program to find sum of 'n' natural numbers.
8. Program to compute the factorial of a given number.
9. Program to generate Fibonacci series.
10. Program to compute Least Common Multiple (LCM).
11. Program to compute Highest Common Factor (HCF).
12. Write a program to insert an element in an array.
13. Write a program to delete an element from array.
14. Write a program for linear searching.
15. Write a program to implement bubble sorting.
16. Program to find the largest and smallest element among 'n' numbers.
17. Program to add and subtract two matrices.
18. Program to compute the transpose of a matrix.

Suggested Readings

1. P.K. Sinha, Priti Sinha, *Computer Fundamentals*, BPB Publications (1992).
2. Byron S Gottfried, *Programming in C- (Schaum's series)*, 2nd edition, McGraw-Hill Education, (1996).
3. E. Balgurusami, *Object Oriented Programming with C++,* McGraw-Hill Education, (2001)
4. Yashwant Kanetkar, *Let us C*, 13th edition, BPB Publications, (2016).
5. K.R. Venugopal, S. R. Prasad, *Programming with C*, Tata McGraw Hill, (1997).