JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
UNIVERSITY COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY HYDERABAD
KUKATPALLY, HYDERABAD

M.Sc. PHYSICS (Full Time) w.e.f. 2022-23

COURSE STRUCTURE

SEMESTER-I

S. No	Code	Subject	L	P	Credits
1	PH101	Mathematical Physics	3	0	3
2	PH102	Classical Mechanics	3	0	3
3	PH103	Electromagnetic Theory	3	0	3
4	PH1E1 PH1E2 PH1E3	**Departmental Elective** a. Electronic Devices b. Material Science c. Physics of Insulating Materials	3	0	3
5	PH1L1	General Physics Lab - I	0	6	3
6	PH1L2	Electronics and Material Science Lab	0	6	3
7	PH1L9	Seminar - I	0	4	2
		Total Credits			**20**

SEMESTER-II

S.No	Code	Subject	L	P	Credits
1	PH201	Quantum Mechanics	3	0	3
2	PH202	Statistical Mechanics	3	0	3
3	PH203	Communication Theory	3	0	3
4	PH2E1 PH2E2 PH2E3	**Open Elective** a. Numerical Methods & C Programming b. Numerical Methods & Python Programming c. Numerical Methods & MAT Lab Programming	3	0	3
5	PH2L1	General Physics Lab -II	0	6	3
6	PH2L2	Programming Lab	0	6	3
7	PH2L9	Seminar - II	0	4	2
		Total Credits			**20**

SEMESTER-III

S. No	Code	Subject	L	P	Credits
1	PH301	Atomic and Molecular Physics	3	0	3
2	PH302	Solid state Physics	3	0	3
3	PH303	Fiber Optics	3	0	3
4	PH3E1 PH3E2 PH3E3	**Departmental Elective** a. Modern Optics b. Physics of Polymers c. Analog Communications	3	0	3
5	PH3L1	General Physics Lab -III	0	6	3
6	PH3L2	Fiber Optics Lab	0	6	3
7	PH3L9	Seminar on Project	0	4	2
		Total Credits			**20**

SEMESTER-IV

S. No	Code	Subject	L	P	Credits
1	PH401	Physics of Nanomaterials	3	0	3
2	PH402	Fiber Optic Sensors	3	0	3
3	PH403	Nuclear Physics	3	0	3
4	PH4E1 PH4E2 PH4E3	**Departmental Elective** a. Physics of Solar Cells b. Synthesis & Characterization of Materials c. Advanced Instrumentation	3	0	3
5	PH4L1	Nanomaterials lab	0	6	3
6		Project			5
		Total Credits			**20**

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L	P	C
3	0	3

PH101 MATHEMATICAL PHYSICS

Unit I	**LEGENDRE AND BESSEL FUNCTIONS**
	Beta and Gamma functions, Definitions and properties, Evaluation of integrals, Legendre and Bessel differential equations solution using Frobenius method, Generating function, Rodrigue's formula(No Proof), Recurrence relations, Orthogonal properties(No Proof).
Unit II	**HERMITE AND LAGUERRE FUNCTIONS**
	Hermite and Laguerre differential equations, Solution by Frobenius method, Rodrigue's formula (No Proof), Generating functions, Recurrence relations, Orthogonal properties.
Unit III	**INTEGRAL TRANSFORMS**
	Fourier transforms: Properties of Fourier transform, Fourier sine and cosine transforms, Modulation theorem, Fourier transform of Dirac delta function, Applications of Fourier transforms. Laplace Transforms : Definition and notation, Properties of Laplace transforms, Laplace transform of Dirac delta function, Inverse Laplace transforms, Properties.
Unit IV	**MATRICES**
	Matrix Algebra, Transpose, Adjoint, Inverse, Conjugate, Hermitian Matrices, Eigen values and Eigen vectors, Characteristic equation, Diagonalization of matrices.
Unit V	**COMPLEX VARIABLES**
	Analytic function, Cauchy, Riemann equations, Cauchy's integral theorem, Residues, Calculation of residues, Cauchy's Residue theorem.

Text Books:	1. Mathematical Physics, by Satya Prakash, 7th Edition, Sultan Chand & Sons.
	2. Complex Analysis, by Churchill.
	3. Mathematical Physics, by B.S Rajput.
Reference Books:	1. Mathematical Physics, by A.K.Ghatak, I.C. Goyal and S.L.Chua.
	2. Advanced Engineering Mathematics, by N.Bali, M.Goyal and C.Watkins.

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PH102 CLASSICAL MECHANICS

Unit I	**NEWTONIAN MECHANICS**
	Introduction, Space and Time-Frame of reference, Newton's laws of motion, Inertial frames, Newtonian Mechanics of one and many particle systems, Conservation laws, Work-Energy theorem, Open Systems with variable mass, Rotating frames, terrestrial and astronomical applications of coriolis force.
Unit II	**LAGRANGIAN DYNAMICS**
	Introduction, Basic concepts, Constraints, Generalized coordinates, Principle of virtual work, D’Alembert’s Principle, Lagrange’s equations from D'Alembert's principle, Gyroscopic forces, Dissipative systems, Gauge invariance, Invariance under Galilean transformation. Generalized momentum and cyclic co-ordinates, Hamiltonian function H and conservation of energy, Hamilton’s equations.
Unit III	**CENTRAL FORCES**
	Introduction, Reduction of Two-body central force problem into the equivalent One-body problem Central force and motion in a plane, Equation of motion under central force and first integrals, Differential equation for an orbit, Inverse square law of force, Kepler’s laws of planetary motion and their deduction, Closure and stability of circular orbits, Artificial satellites.
Unit IV	**VARIATION PRINCIPLES**
	The calculus of variations and Euler Lagrange’s equations. Deduction of Hamilton’s principle from D’Alembert’s principle. Modified Hamilton’s principle, Δ -variation, Principle of least action, Other forms of principle of least action.
Unit V	**CANONICAL TRANSFORMATIONS**
	Canonical transformations, Legendre transformations, Generating functions, Procedure and conditions for application of canonical transformations. Poisson’s brackets, Lagrange brackets. Relation between Lagrange and Poisson brackets.

Text Books:	1. Classical Mechanics, by H Goldstein, Addison Wesley.
	2. Classical Mechanics, by J C Upadhyaya, HPH
	3. Classical Mechanics, by N C Rana and P S Joag, Tata Mc Graw Hill.
Reference Books:	1. Classical Mechanics, by A Sommerfeld, Academic Press.
	2. Introduction to Classical Mechanics, by Takwale and Puranik, TMH.

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PH103 ELECTROMAGNETIC THEORY

Unit I	**POTENTIALS AND ELECTROMAGNETIC WAVES**
	Electro-Static potentials**:** Special techniques for calculating electrostatic potential: Poisson's and Laplace's equations-solutions of Laplace's equations for electrostatic potential in Cartesian, spherical polar coordinates, Multipole expansion of a system of charges in an electrostatic field, The scalar and vector magnetic potentials. Maxwell's Field Equations: Derivation of Maxwell's equation, General wave equations, Guage transformations, Lorentz and Coulomb gauges, Momentum, angular momentum and free energies of electromagnetic field, Poynting theorem (work energy theorem in electrodynamics).
Unit II	**PROPAGATION OF PLANE ELECTROMAGNETIC WAVES**
	Electromagnetic (EM) waves in unbounded media, EM wave equation for a homogeneous isotropic dielectric medium, Propagation of plan EM waves in free space, Propagation of EM waves homogeneous isotropic dielectric medium, Energy transmitted by a plane EM wave, Propagation of EM wave in conducing medium, Attenuation and Skin effect, Energy transmitted, Polarization of EM wave.
Unit III	**INTERACTION OF ELECTROMAGNETIC WAVES WITH MATTER**
	Propagation of EM waves in bounded media, Boundary conditions for EDB and H-reflection and Refraction of plane EM waves at plane interface between two dielectrics, Laws of reflection and refraction, Fresnel's relations-Reflection (R) and transmission (T) coefficients, Brewester's angle, Total internal reflection, Reflection and Refraction of plane EM waves at plane interface between non- conductors, Normal and anomalous.
Unit IV	**ELECTROMAGNETIC RADIATION**
	Electromagnetic Radiation: Inhomogeneous wave equation for potentials, Retarded potentials Multipole expansion of EM radiation for harmonically oscillating source, Long wavelength approximation, Oscillating electric dipole radiation, Oscillating magnetic dipole radiation, Radiation from centered linear antenna Radiation from accelerated charges: Lienard Wiechert potentials, Electromagnetic field of a charge in arbitrary motion.
Unit V	**WAVE GUIDES**
	Rectangular guides, Transverse magnetic waves in rectangular guides, Transverse electric waves in rectangular guides, Impossibility of TEM wave in wave guides, Bessel functions, Solution of the field equation, Cylindrical co-ordinates, TM and TE waves in circular guides, Wave impedances and characteristics impedance, Attenuation factor of wave guides.

Text Books:	1. Introduction to Electrodynamics, by D.J.Griffith, PHI.
	2. Classical Electrodynamics, by J.D. Jackson,3rd Edition, Wiley India.
Reference Books:	1. Electromagnetic Theory And Electrodynamics, by Satya Prakash, Kedarnath Ramnath Publisher.
	2. Electromagnetic Wave and Radiating Systems, by Edward C. Jordan, Keith G. Balmain, 2nd Edition.

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PH1E1 ELECTRONIC DEVICES

Unit I	**REGULATED POWER SUPPLIES**
	Basic principles of regulated power supply, Stabilization, Zener regulator, Transistorized series regulator, Fixed IC voltage regulators using IC 78XX and 79XX. Semiconductor Devices: Structure-working and I-V characteristics of JFET, UJT and MOSFET. Microwave Devices: Structure, working and characteristics of Tunnel diode, Gunn diode, PIN diode.
Unit II	**FEEDBACK IN AMPLIFIERS**
	Concept of feedback, Positive and negative feedback, Barkhausen Criterion, Feedback gain, Advantages of negative feedback in amplifier. RC Oscillators: Phase shift and Wein bridge oscillators.LC Oscillators: Hartley and Colpitts oscillators, Crystal oscillator.
Unit III	**OPERATIONAL AMPLIFIERS**
	Characteristics of ideal operational amplifier, Block diagram, Emitter coupled differential amplifier and its transfer characteristics, Inverting and non-Inverting amplifiers, Summing and difference amplifiers, Integrator, Differentiator, Comparator, Rectangular and triangular wave generators. Timer IC 555: Block diagram of IC555, Astable and Mono-stable and Bistable multi-vibrators using IC555.
Unit IV	**LOGIC CIRCUITS**
	Min terms and Max terms, De-Morgan laws, Simplification of Boolean equation: Sum of Products and Product of Sums, Karnaugh maps, Multiplexers and De-multiplexers. Flip-Flops: RS, D, JK, MS-JK flip flops and their truth tables and timing diagrams. Registers: Types of registers, Serial in Serial out, Serial in parallel out, Parallel in Serial out and parallel in parallel out registers. Counters: Asynchronous and Synchronous counters, Modulus N counter, Decade counter.
Unit V	**INTRODUCTION TO MICROPROCESSORS**
	Introduction to Microprocessors, Architecture of 8085, Addressing modes, Instruction Set of 8085, Simple Assembly language programs, 8 bit addition, subtraction and multiplication.

Text Books:	1. Microelectronics, by Milliman and Grabel.
	2. Operational Amplifiers, by Ramakanth Gayakward.
	3. Physics of Semiconductor Devices, by S.M. Sze, Kwok K. Ng, John, Wiley & Sons.
	4. Microprocessors, Architecture, Programming and Applications with 8085/8080, by Ramesh Gaonkar.
Reference Books:	1. Digital Principles and Applications, by Malvino and Leach.
	2. Microprocessors, by B. Ram.

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PH1E2 MATERIALS SCIENCE

Unit I	**ATOMIC STRUCTURE AND INTERATOMIC BONDING**
	Introduction, Atomic Structure, Fundamental Concepts, Electrons in atoms, the Periodic Table, Atomic Bonding in Solids, Bonding Forces and Energies, Primary interatomic Bonds, Secondary Bonding or Vander Waals Bonding, Mixed Bonding, Molecules bonding type, Material Classification.
Unit II	**DIELECTRICS AND FERROELECTRICS**
	Macroscopic description of the static dielectric constant, the electronic and ionic polarizabilities of molecules,Orientational Polarization, Measurement or dielectric constant of a solid, the internal field of Lorentz,Clausius- Mosotti relation, Elementary ideas on dipole relaxation, Classification of ferroelectric crystals,$BaTiO_3$ and KDP,Dielectric theory of ferro-electricity,Spontaneous polarization and ferroelectric hysteresis.
Unit III	**MAGNETIC PROPERTIES**
	Quantum theory of diamagnetism, Origin of permanent magnetic moment, Theories of paramagnetism,Paramagnetic cooling, Spontaneous magnetization, Weiss theory of spontaneous magnetization, Nature and origin of the Weiss molecular field, Heisenberg exchange interaction, Hysteresis, the Block wall-Neel's theory of Antiferromagnetism, Ferromagnetism, Ferrites and their applications (basic concepts only).
Unit IV	**SUPERCONDUCTIVITY**
	Occurrence of Superconductivity, Experimental observations, Persistent currents, Effect of magnetic fields, Meissner effect, Type I and Type II super conductors, Intermediate states, Entropy and heat capacity, energy gap, Isotope effect, Thermal conductivity. Theoretical explanations, London's equation, Penetration depth, Coherence length Cooper Pairs, Elements of BCS theory, Giaver tunneling Josephson effects (basic ideas).
Unit V	**FIBER OPTICS AND LASERS**
	Introduction, Ray theory transmission, Types of fibers, Photo conductor, Fiber optic sensors, Lasers basic concepts, condition for lasing action, Ruby laser, Helium – Neon laser Semiconductor lasers, applications.

Text Books:	1. Materials Science & Engineering, by W.D.Callister (Jr).
	2. Materials Science, by M.Arumugam.
Reference Books:	1. Introduction to Materials Science, by Vijay Kumar S. M.

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3	0	3

PH1E3 PHYSICS OF INSULATING MATERIALS

Unit I	**IONICS AND SUPERIONICS**
	Superionic solids, Classification of superionic solids, Materials and structures, Structural characterization, Thermodynamic properties, Ionic transport (microscopic nature),Ion dynamic, Applications superionic solids with special reference to solid state batteries.
Unit II	**PHYSICS OF AMORPHOUS MATERIALS**
	Introduction and preparation techniques, Glasses and glass transition, Structure of glass, atomic ordering in amorphous materials, Optical properties amorphous materials, Applications of amorphous materials.
Unit III	**DIELECTRICS**
	Single relaxation times, Debye's equations and Cole-Cole plots, Distribution of relaxation times, Cole-Davidson plots, Random approximation, Variation of dielectric properties with frequency, temperature, pressure, and composition. (Dielectric properties of mixtures), Dielectric properties of glasses and polymers.
Unit IV	**MEASUREMENT**
	Measurement of dielectric properties, Scherring bridges meters and LCR meters and impedance analyzers, Review of piezoelectric and piezoelectric materials, Lead based piezoelectric and applications.
Unit V	**FERROELECTRICS**
	Review of types of ferroelectrics and their important features methods of preparation of bulk ceramic ferroelectrics, Characterization of ferroelectrics, Small signal dielectric measurements, Method of measuring spontaneous polarization,Pyroelectricity,Polarization reversal, Theories of ferroelectricity, Dipole theory, Devonshire theory and pseudo spin theory, Application of ferroelectric materials, Piezoelectric transducers, Pyroelectric detectors, Electro optic application, Second harmonic generators, SAW devices and memory

Text Books:	1. Materials Science and Engineering, by V.Raghavan.
	2. Solid State Physics, by Kittel.
Reference Books:	1. Materials Science and Engineering, by W.D.Callister.
	2. Materials Science and Engineering by S.M.Srivasthava.

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PH1L1 GENERAL PHYSICS LAB – I

S.No.	Name of the Experiment
1	Young's Modulus of a Spring
2	Melde's Experiment
3	Cauchy's Constants for ordinary Prism using white light
4	Diffraction Grating Using Sodium light
5	Hall Effect
6	B-H Curve
7	e/m ratio using small bar magnet
8	Refractive index of liquids using Hallow prism
9	Thermistor Characteristics
10	Coefficient of thermal expansion of solids

Note: Any 8 experiments are to be performed by each student

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0	6	3

PH1L2 ELECTRONICS LAB

S.No.	Name of the Experiment
1	Zener diode applications as voltage regulator
2	Common Emitter – Characteristics
3	RC Phase shift oscillator
4	Characteristics of PIN diode
5	Characteristics of LED.
6	Frequency response of inverting amplifier using IC 741
7	Operation of Wein Bridge Oscillator using IC741
8	Astable multivibrator using 555 IC
9	Construction of decade counters using flip flops
10	Verification of truth tables of AND, OR, NOT, XOR gates using discrete components

Note: Any 8 experiments are to be performed by each student

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L	P	C
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PH201 QUANTUM MECHANICS

Unit I	FUNDAMENTAL CONCEPTS
	Linear Vector space, Dirac's Ket and bra notion, Eigen value equation, Eigen kets and Eigen values, Degenerate and non – Degenerate states, Completeness relation, Waves functions in position and momentum space, Normalization and orthogonality of wave functions, Change of basic observables, Operators, Hermitian operators and their properties ,Commuting and non-commuting operators, Physical significance, Matrix representations of vectors and operators, Observable and expectation value of an observable, Party operator, Projection operator significance, Basic commutation relations, Uncertainty principle between any two non- commuting operators.
Unit II	ANGULAR MOMENTUM FORMALISM
	Orbital Angular Momentum, Commutation Relations involving : L^2, L_x, L_y, L_z -Eigen values and Eigen functions of L^2 ,Generalized angular momentum, J- commutations relations between J^2 and components of J, J and J, Eigen values of J^2 and J_z ,Matrix representation for J^2 and J_z ,Spin angular momentum, Pauli spin matrices and their properties. Addition of angular memento,Clebsch- Gordon coefficients, Recursion relations ,C-G coefficients for $J_1={}^1/_2, J_2={}^1/_2,$ and $J_1={}^1/_2, J_2=1$, as example
Unit III	TIME DEPENDENT PERTURBATION
	Kinematics of Scattering Process: Differential and total cross-section, Asymptotic from of scattering wave function, Scattering amplitude by Green's function method, Born approximation method and screened potential and square well potential as examples, Partial wave analysis and phase shift, Optical theorem, Relationship between phase shift and potential, Scattering by Hard sphere.
Unit IV	TIME INDEPENDENT PERTURBATION THEORY
	Approximation Methods, Non-degenerate case, First-and second-order cases, Examples of harmonic and an-harmonic Oscillators, Degenerate case, Stark effect for H-atom for n=2 level, Variation method, Helium atom ground state, WKB approximation method, Connection formulae, Application to Alpha Decay.
Unit V	RELATIVISTIC QUANTUM MECHANICS
	Klein- Gordon Equation, Plane wave solution and equation of continuity, Probability density, Dirac Equation, Alpha, Beta- matrices, Plane wave solution, Significance of negative energy states, Spin of Dirac particle relativistic potential, Total angular moment, Particle in magnetic field, Spin magnetic moment, Properties of gamma matrices, Dirac' equation in covariant form.

Text Books:	1. Quantum Mechanics, by L I Schiff, McGraw Hill.
	2. Quantum Mechanics, by Mathews and Venkateshan.
Reference Books:	1. Quantum Mechanics, by E. Merzbacher, Wiley.
	2. Quantum Mechanics, by B Craseman and J D Powell, Addison Wesley.

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L	P	C
3	0	3

PH202 STATISTICAL MECHANICS

Unit I	**BASICS OF STATISTICAL MECHANICS**
	Objective of statistical mechanics macro states, Microstates, Phase space concept of Ensembles, Ensemble Average,Liouville's theorem, Conservation of extension in phase space, Equal apriori probability, Statistical equilibrium, Entropy and probability, Micro canonical ensemble, Entropy of an ideal gas using micro canonical ensemble, Gibb's paradox ,Sackur tetrode equation.
Unit II	**ENSEMBLES**
	Quasi static processes, Equilibrium conditions, Thermal equilibrium, Mechanical equilibrium, Concentration equilibrium, Canonical ensemble entropy of an ideal gas, Sackur tetrode equation, M.B.distribution, Maxwell velocity distribution, Equipartition of energy.
Unit III	**PARTITION FUNCTIONS**
	Grand canonical ensemble and ideal gas in grand canonical ensemble, Entropy, Sackur – tetrode equation, Canonical partition function, Grand canonical partition function, Ideal gas in grand canonical ensemble, Entropy, Sackur –tetrode equation, Molecular partition function, Translational partition function, Rotational partition function, Electronic and Nuclear partition functions, Specific heat of diatomic molecule.
Unit IV	**BOSE EINSTEIN STATISTICS**
	Einstein distribution, Bose Einstein condensation, Expression of energy and pressure of an ideal Bose, Einstein gas, Black body radiation and Planck's radiation law, Dulong and Petit's law, Einstein & Debye's theories of specific heats of solids, Liquid Helium, Two fluid model of liquid helium –II,Super fluid phase of helium.
Unit V	**FERMI –DIRAC STATISTICS AND FLUCTUATIONS**
	Fermi –Dirac distribution, Degeneracy, Electrons in metals, Thermionic emission, Magnetic susceptibility of free electrons, Fluctuations in ensembles, Energy and pressure of an ideal, F-D gas phase transitions of first and second kind examples, Brownian motion.

Text Books:	1. Statistical Mechanics, by B.K. Agarwal and Melvin Eisner.
	2. Statistical Mechanics, by Gupta Kumar.
	3. Statistical Mechanics, by Satya Prakas and Agarwal.
Reference books:	1. Elementary Statistical Mechanics, by C. Kittel.
	2. Statistical and Thermal Physics, by F.Reif.

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PH203 COMMUNICATION THEORY

Unit I	**INTRODUCTION TO FOURIER SERIES**
	Signal analysis, The sampling function, Response of a linear system, normalized power, normalized power in Fourier Expansion, Fourier Transform, Fourier transforms of discrete functions.
Unit II	**AMPLITUDE MODULATION SYSTEMS**
	Frequency translation, A method of frequency translation, Recovery of baseband signal, Synchronous detection, Amplitude modulation, Envelope detection, Spectrum of an amplitude modulated signal, Modulators and balanced modulators, DSB, Single sideband modulation (SSB), Vestigial Side band modulation (VSB), Multiplexing.
Unit III	**FREQUENCY MODULATION SYSTEM**
	Angle modulation, Phase and frequency modulation, spectrum of an FM signal-Sinusoidal Signal, Some features of Bessel coefficients, Phasor diagram of FM Signal, Reactive Modulators, FM demodulators
Unit IV	**PULSE MODULATION SYSTEMS**
	Sampling theorem. Types of sampling. Principles of PAM, PWM methods. Pulse code modulation. Delta modulation.
Unit V	**NOISE**
	Thermal noise, shot noise, noise power spectral density, Noise figure and noise temperature. Available gain. Noise figure of a single amplifier.

Text Books:	1. S. S. Haykins communication System, Wiley Ester
	2. Principles of Communication, by Taub and Schilling (T.M.H).
Reference books:	1. Communication Systems, by A.B. Carlson (I S E).
	2. Principles of Communications: Systems, Modulation, and Noise, by Rodger E. Ziemer, William H. Trante.

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PH2E1 NUMERICAL METHODS AND C PROGRAMMING

Unit I	**SOLUTIONS OF EQUATION**
	Methods for determination of zeroes of linear and non linear algebraic equations and transcendental equations, Convergence of solutions, Solutions of simultaneous linear equations, Gaussian elimination, Pivoting, Iterative Method, Matrix inversion, Eigen values and eigenvectors of matrices, Power and Jacobi Methods.
Unit II	**NUMERICAL DIFFERENTIATION AND INTEGRATION**
	Newton-Cotes formulae, error estimates, Gauss method. Random variation, Monte Carlo evaluation of Integrals, Methods of importance sampling, Random walk and Metropolis method, Numerical solution of ordinary differential equations, Euler and Runge Kutta methods, Predictor and corrector method, Elementary ideas of solutions of partial differential equations.
Unit III	**INTRODUCTION TO PROGRAMMING**
	Programming languages and generations, Categorization of high-level languages, Introduction to C: Introduction, Structure of C program, Keywords, Identifiers, Variables, constants, I/O statements, Operators, Precedence, and associativity.
Unit IV	**INTRODUCTION TO DECISION CONTROL STATEMENTS**
	Introduction to decision control statements: Selective, Looping, and nested statements, Functions: Introduction, Uses of functions, Function definition, Declaration, Passing parameters to functions, Recursion.
Unit V	**ARRAYS**
	Arrays: Introduction, Declaration of arrays, Accessing and storage of array elements, 1-dimensional array, 2-D arrays, Matrix operations.

Text Books:	1. C Language And Numerical Methods, by Xavier, New Age International.
	2. Numerical Methods, by R. K. Jain, S. R. K. Iyengar, New Age International
Reference books:	1. Numerical Analysis, by Rajaraman.
	2. C Programming using turbo C++, by Robart Lafore, 2nd edition.
	3. Let Us 'C', by Yashwanth Kanithkar.

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L	P	C
3	0	3

PH2E2 NUMERICAL METHODS AND PYTHON PROGRAMMING

Unit I	**SOLUTIONS OF EQUATION**
	Methods for determination of zeroes of linear and non linear algebraic equations and transcendental equations, Convergence of solutions, Solutions of simultaneous linear equations, Gaussian elimination, Pivoting, Iterative Method, Matrix inversion, Eigen values and eigenvectors of matrices, Power and Jacobi Method.
Unit II	**NUMERICAL DIFFERENTIATION AND INTEGRATION**
	Newton-Cotes formulae, Error estimates, Gauss method, Random variation, Monte Carlo evaluation of Integrals, Methods of importance sampling, Random walk and Metropolis method, Numerical solution of ordinary differential equations, Euler and Runge Kutta methods, Predictor and corrector method, Elementary ideas of solutions of partial differential equations.
Unit III	**INTRODUCTION TO OBJECT ORIENTED PROGRAMMING**
	Introduction to Object Oriented Programming: Computer Programming and Programming Languages, Programming Paradigms, Features of Object Oriented Programming, Merits and Demerits of OOPs . Basics of Python Programming: Features of Python, Variables, Identifiers, Data types, Input/ Output operations, Operators and Expressions, Operations on Strings, Type Conversion.
Unit IV	**DECISION CONTROL STATEMENT**
	Decision Control Statement: Selection/Conditional Branching, Loop Control Structures, Nested Loops. Functions and Modules: Uses of functions, Function definition, function call, Variable scope and Lifetime, Recursion, Lambda functions, Recursive Functions, Modules, Packages.
Unit V	**CLASSES AND OBJECTS**
	Classes and Objects: Introduction, Classes and Objects, Init method, Class variables and Object variables, Public and Private Data members, Calling methods from other methods, Built-in class attributes, Garbage collection, Class methods, Static methods.

Text Books:	1. Numerical Methods, by R. K. Jain, S. R. K. Iyengar, New Age International Publishers.
	2. Python Programming And Numerical Methods: A Guide For Engineers and Scientists, Academic Press.
Reference books:	1. Introductory Methods of Numerical Analysis, by Sastry.
	2. Numerical Recipes in 'C', by S.A.Teukolsky, W.T.Wellering, W.H.Press (2nd edition).
	3. Python Programming, by Reema Thareja, Oxford Press.
	4. Python in easy steps: Makes Programming Fun, by Mike Mc Grath, Kindle Edition.

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3	0	3

PH2E3 NUMERICAL METHODS AND MATLAB PROGRAMMING

Unit I	**SOLUTIONS OF EQUATION**
	Methods for determination of zeroes of linear and non linear algebraic equations and transcendental equations, Convergence of solutions, Solutions of simultaneous linear equations, Gaussian elimination, Pivoting, Iterative Method, Matrix inversion, Eigen values and eigenvectors of matrices, Power and Jacobi Method.
Unit II	**NUMERICAL DIFFERENTIATION AND INTEGRATION**
	Newton-Cotes formulae, Error estimates, Gauss method. Random variation, Monte Carlo evaluation of Integrals, Methods of importance sampling, Random walk and Metropolis method, Numerical solution of ordinary differential equations, Euler and Runge Kutta methods, Predictor and corrector method, Elementary ideas of solutions of partial differential equations.
Unit III	**INTRODUCTION TO MATLAB**
	Introduction to MATLAB Programming environment, Basics of MATLAB, Matrices and Vectors: indexing, Matrix manipulation, matrix operations, Built in functions of matrices in MATLAB, Scripts and functions, Script file, Function file, Recursive functions, Solving system of equations, Gaussian Elimination, Eigen values and Eigen vectors, matrix factorization.
Unit IV	**CURVE FITTING**
	Curve fitting: Polynomial curve fitting, Least square fitting, Interpolation: Newton and Lagrange interpolation, Data analysis and statistics, Ordinary differential equations, Non linear algebraic equations, roots of polynomials. Graphics: 2D plots, 3D–plots using MATLAB tools.
Unit V	**INTERPOLATION AND APPROXIMATION**
	Interpolation and Approximation, MATLAB’s Integration Routines, Monte Carlo Integration and Monte Carlo Simulations, Ordinary Differential Equations, Euler Methods, Constants of the Motion, Runge-Kutta Methods, Convergence, Adaptive Step sizes, Runge-Kutta-Fehlberg,

Text Books:	1. Getting Started with MATLAB, by Rudra Pratap, Oxford University Press.
	2. Numerical Methods By R. K. Jain, S. R. K. Iyengar, New Age International Publishers.
Reference books:	1. MATLAB Handbook with Applications to Mathematics, Science, Engineering, and Finance, by Jose Miguel David Baez-Lopez, David Alfredo Baez Villegas (1st Edition).

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PH2L1 GENERAL PHYSICS LAB – II

S.No.	Name of the Experiment
1	Young's modulus- bending of beam (Uniform & Non-uniform).
2	Diffraction by single slit using sodium light.
3	Photo cell- Planck's constant using filters.
4	Polarimeter- Specific rotatory power of sugar solution.
5	Stefan's constant.
6	Heating efficiency of a kettle.
7	Compound pendulum.
8	Viscosity of liquids using oscillating disc method.
9	Thermo electric Power.
10	Magnetic Susceptibility of liquid.

Note: Any 8 experiments are to be performed by each student.

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PH2L2 PROGRAMMING LAB

S.No.	Name of the Experiment
1	Solution of transcendental equation using Bisection method
2	Newton-Raphson method
3	Simultaneous linear equation solution using Gaussian elimination method
4	Simultaneous linear equation solution using Gauss-Seidel method
5	Interpolation using Newton's divided difference method
6	Interpolation using Lagrange method
7	Integration using Trapezoidal method
8	Numerical integration using Simpsons 1/3 rule
9	Ordinary differential equations solution using Euler's method
10	Solve ordinary differential equations using Range-Kutta method

Note: Any 8 experiments are to be performed by each student.

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PH301 ATOMIC AND MOLECULAR PHYSICS

Unit I	ATOM SPECTRA
	Different series in alkali spectra (main features), Ritz combination principle, Terms for equivalent & non-equivalent electron atom, Term values in alkali spectra and quantum defect, L- S and j- j coupling; Energy levels and spectra, Spectroscopic terms, Spin –Orbit interaction, Doublet structure in alkali spectra, Selection rules, Intensity rules, Alkali-like spectra, Lamb shift, Many electron atoms, Isotope shift, Hyperfine splitting of spectral lines, Selection rules, Lande interval rule.
Unit II	**MOLECULAR SPECTRA**
	Types of molecular spectra, Regions of the spectrum, Salient features of rotational spectra, Rotational spectra of diatomic molecule as a rigid rotator, Energy levels and spectra of a non-rigid diatomic molecule, Effect of isotopic substitution on rotational spectra, Salient features of vibrational, Rotational spectra, Vibrating diatomic molecule as a harmonic oscillator and as anharmonic oscillator, Diatomic molecule as rigid rotator and harmonic oscillator, Diatomic molecule as a non-rigid rotator and an harmonic oscillator.
Unit III	**RAMAN AND INFRARED (IR) SPECTRA**
	Raman effect and its salient features, Classical and quantum theory of Raman effect, Normal vibrations of CO2 and H2O molecules, Vibrational and rotational Raman spectra, Infrared spectroscopy, Basic concept of IR spectroscopy, IR spectrophotometer, Principle and instrumentation, FTIR principle and working, Interpretation of data from Raman and IR spectroscopy.
Unit IV	**ELECTRONIC SPECTROSCOPY**
	Electronic spectra of diatomic molecules, Vibrational coarse structure, Franck- Condon Principle, Dissociation energy and dissociation products, Rotational fine structure of Electronic, Vibrational transition, Production of excited state, Selection rules, Frank-Condon principle, Jablanski diagram and qualitative treatment of small molecule and large molecule limit for non radiative transitions.
Unit V	**RESONANCE SPECTRA**
	Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (ESR) Spectroscopy Nuclear spin and magnetic moment, Origin of nuclear magnetic resonance (NMR) spectra, Theory of NMR spectra-Relaxation process, Bloch equations, Chemical shift, Experimental study of NMR spectroscopy, Experimental technique, ESR spectroscopy, Origin and resonance condition, Quantum theory, Design of ESR spectrometer, Hyperfine structure of ESR absorptions, Fine structure in ESR spectra, ESR instrumentation, Application of ESR.

Text Books:	1. Introduction to Atomic Spectra, by Harvey Elliott White, Mc Graw Hill.
	2. Atomic & Molecular Spectra, by Raj Kumar.
	3. Molecular Spectra & Molecular Structure, by Gerhard Herzberg (Vol-I).
Reference books:	1. Fundamentals of Molecular Spectroscopy, by C.N. Banwell.
	2. Atomic Physics, by C.J. Foot, Oxford University Press.

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PH302 SOLID STATE PHYSICS

Unit I	**CRYSTALLOGRAPHY**
	Crystalline solids, Unit cells and direct lattices, Two and three dimensional bravais lattices, X -ray diffraction, Bragg's law, The reciprocal lattice and its applications to diffraction techniques, The Laue and powder diffraction methods for experimental determination of lattice parameter, Crystal structure factor.
Unit II	**DEFECTS IN CRYSTALS: CLASSIFICATION**
	Classification of imperfections, Point defects, Schottky and Frenkel defects, Expressions for equilibrium defect concentrations, Diffusion, Ionic conductivity in alkali halide, Kirkendal effect, Color centers,F-F1 and V centers, Production of color centers, Line defects,Dislocation,Burger vector, Frank -Reed mechanism of dislocation, Dislocation multiplication.
Unit III	**TRANSPORT PHENOMENA AND BAND THEORY OF SOLIDS**
	Concept of electrical and thermal resistivity expression for thermal and electrical conductivities for metals, Lorenz number, Different scattering mechanisms, Matheissens rule, Formulation of Boltzmann's transport equation, Relaxation time, Somerfield model its consequences, Electron – Lattice interaction (Quantitative only),Motion of electron in periodic potential, Bloch function, Kronig-Penney model, Formation of energy bands in solids, Concept of effective mass, Brillouin zones,E v/s K curve, Distinction between metals insulators and semiconductors.
Unit IV	**SUPERCONDUCTIVITY**
	Concept of zero resistance, Magnetic behavior, Distinction between a perfect conductor and super conductor, Meissner effect Isotope effect, Persistent currents, Specific heat behavior, Type-I and Type-II super conductors, London's equations, Penetration depth, BCS theory, Josephson Junctions High T_c super conductors, Application of super conductors.
Unit V	**DIELECTRICS AND FERROELECTRICS**
	Static dielectric constant of solids, Various contributions to the polarisability, The local electric field, Clausius- Mosotti relation, Dielectric in an alternating field, The complex dielectric constant and dielectric loss. Ferro electricity: Classification and properties of ferroelectrics, Spontaneous polarization, Ferroelectric domains, Dipole theory of Ferro electrics, Thermodynamics of Ferro electric transitions, Anti ferroelectricity, Applications.

Text Books:	1. Solid state Physics, by A.J Dekker, Macmillan Publications.
	2. Introduction to Solid State Physics, by Charles Kittel (VII Edn.).
	3. Solid State Physics, by R.L Singhal ,Kedarnath, Ramnath & Co.
	4. Fundamentals of Solid State Physics, by Saxena, Gupta, Saxena, Mandal.
Reference books:	1. Solid State Physics, by S.O.Pillai, New Age International Publishers.
	2. High T_c Super conductivity, by CNR Rao & S.V. Subramanyam.
	3. Elementary Solid State Physics – M. Ali Omar, Pearson Publishers.
	4. Solid State Electronic Devices, by Ben.G. Streetman, Sanjay Benerjee, Prentice Hall Series.

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PH303 MODERN OPTICS

Unit I	**PRINCIPLES OF LASER AND LASER RATE EQUATIONS**
	Introduction, Light-matter interaction, Properties of Laser beams, Emission and absorption of Radiation, Pumping mechanism, Population inversion, Optical gain, Einstein's coefficients, Laser rate equations: two level, three level and four level Lasers, Line broadening mechanisms.
Unit II	**OPTICAL RESONATORS**
	Introduction, Modes of rectangular cavity and open planar resonators, Confocal Resonator, The Quality factor, Variation of laser power around threshold, Optimum output coupling, Ultimate line width of the laser, Q-switching, mode locking in lasers.
Unit III	**TYPES OF LASERS AND APPLICATIONS**
	Solid state Lasers: Ruby Laser, Nd-YAG Laser, Atomic gas lasers: He-Ne laser, Argon ion lasers, Molecular gas lasers: CO_2 laser, Nitrogen lasers, Dye lasers and semiconductor lasers. Applications: Lasers in material processing and electronics industry, lasers in Nuclear energy, medicine and surgery, defense and optical communications.
Unit IV	**HOLOGRAPHY**
	Introduction to Holography recording of amplitude and phase, The recording medium, Reconstruction of original wave front, Image formation by wave front reconstruction, Gabor Hologram, Limitations of Gabor Hologram Leith, Upatneik's off, Axis hologram, Fourier transform Hologram, Volume Holograms, Applications of Holograms.
Unit V	**FOURIER OPTICS**
	Non-linear optics: origin of optical non linearity, Harmonic, Generation, Second harmonic generation, Third harmonic generation, Phase matching, Optical mixing, Parametric generation of light, Parametric light oscillator, Frequency up conversion, Self focusing of light, Phase conjugate optics.

Text Books:	1. Optical Electronics, by Ghatak and Thyagarajan.
	2. Principles of lasers, by 0. Svelto.
Reference books:	1. Lasers and Non –Linear Optics, by B.B. Laud, Wiley Eastern. Ltd.
	2. Modern optics, by Fowels.

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PH3E1 FIBER OPTICS

Unit I	**PROPAGATION IN FIBER**
	Introduction to Fiber propagation using a Ray Model, Material Dispersion. Refractive index theory of a bulk media, Experimental values, Time dispersion in bulk media, The combined effect of Material & Multipath Dispersion, RMS pulse widths and frequency Response.
Unit II	**FABRICATION & ASSESSMENT OF FIBERS**
	Fiber production Methods, Double crucible method, Vapor axial deposition (VAD) method, MCVD method, Cables, Splices & connectors, Attenuation Mechanisms in optical fibers.
Unit III	**WAVE PROPAGATION IN STEP INDEX FIBERS**
	Modes and Rays, Wave Propagation modes in an ideal step-index Filter, Solution of wave equation, Solution for propagation constant, Variation of propagation constants with frequency, Weakly guiding solutions, Types of single mode fibers.
Unit IV	**WAVE PROPAGATION IN GRADED INDEX FIBERS**
	Modes in graded- Index Fibers, The equivalence of the WKB Approximation & Ray Modal. Intermode Dispersion in graded-Index Fibers, Intramode Dispersion in graded-Index Fibers, Total dispersion in Graded Index Fibers.
Unit V	**OPTICAL AMPLIFIERS**
	Basic applications and types of optical amplifiers, Semiconductor optical amplifiers, Raman amplifiers, Erbium doped fiber amplifiers, Amplifier noise, System application.

Text Books:	1. Optical Communication System – John Gowar
	2. Optical Fiber Communications – John M Senior
Reference Books:	1. Optical Fiber Communications by D J Keiser
	2. Introduction to Fiber Optics by Ajoy Ghatak & K. Thyagarajan

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PH3E2 PHYSICS OF POLYMERS

Unit I	**INTRODUCTION TO POLYMERS**
	Introduction to polymers, Classification of polymers thermoplastics and thermosets, Glass transition temperature (T_g), Melting temperature (T_m), Control of T_m and T_g and relation between them, Dependence of T_m and T_g on copolymer composition.
Unit II	**POLYMER STRUCTURES**
	Introduction, Hydrocarbon molecules, Polymer molecules, the chemistry of polymer molecules, Molecular weight, Molecular shape, Molecular structure, Molecular configurations, Thermoplastic and Thermosetting polymers, Copolymers, Polymer crystalline, Polymer crystals.
Unit III	**CLASSIFICATION OF POLYMERS**
	Polymer additives: Plasticizers, and reinforce other important additives: Stabilizers, flame retardants, Biocious colorants, Polymer blends, Polymer composites, Properties, Toughened plastics and phase separated blends.
Unit IV	**ANALYSIS OF POLYMERS**
	Analysis and testing of polymer by spectroscopic memory Infrared spectroscopy, Nuclear magnetic resonance, X-ray diffraction, Thermal analysis of polymer: Differential scanning calorimetry, Differential Thermal Analysis and Thermo gravimetric method.
Unit V	**SUPER IONIC SOLIDS**
	Super Ionic solids, Classification, Ionic Transport, Ion Dynamics, Polymer electrolytes and their advantages, Applications with special reference to batteries.

Text Books:	1. An Introduction to Polymer Physics-I, by Perepechko.
	2. Polymer Science and Technology, by Joel.R.Fried.
Reference Books:	1. Text Book of Polymer Science, by Fred W Billmeyer.
	2. Super Ionic Solids, by S. Chandra.

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PH3E3 ANALOG COMMUNICATIONS

Unit I	AMPLITUDE MODULATION
	Introduction to communication systems, Need for modulation, Frequency division multiplexing, Amplitude modulation, Time domain and frequency domain description, Generation of AM waves, Square law modulator, Detection of AM waves, Square law detector, Envelop detector, Double sideband suppressed, Carrier modulators.
Unit II	**SSB MODULATION**
	Introduction to Hilbert transform, Frequency domain description, Frequency discrimination method for generation of AM SSB Modulated wave, Time domain description, Phase discrimination method for generating AM SSB Modulated waves, Demodulation of SSB waves, Vestigial sideband modulation.
Unit III	**ANGLE MODULATION**
	Basic concepts, Frequency modulation, Single tone frequency modulation, Spectrum analysis of sinusoidal FM wave, Narrow band FM, Wideband FM, Constant average power, Transmission bandwidth of FM wave, Generation of FM waves, Direct FM, Detection of FM waves.
Unit IV	**NOISE**
	Resistive noise source(thermal), Arbitrary noise sources, Effective noise temperature, Average noise figures, Average noise figure of cascaded networks, Narrowband noise, Noise in analog communication system, Noise in DSB and SSB System, Noise in AM system.
Unit V	**RECEIVERS**
	Radio receiver, Receiver types, Tuned radio frequency receiver, Super heterodyne receiver, RF Section and characteristics, Frequency changing and tracking, Intermediate frequency, AGC, FM receiver, Comparison with AM receiver, Amplitude limiting, Pulse modulation, Types of pulse modulation.

Text Books :	1.Communication Systems by Simon Haykins, John wiley & Sons, IV Edition.
	2.Electronic communications – Dennis Roddy & John Coolean, IV Edition,PEA, 2004
Reference Books:	1. Analog and Digital Communications-Simon Haykins, John Wiley,2005.
	2. Communications Systems – B.P.Lathi, BS Publicaions, 2004.

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PH3L1 GENERAL PHYSICS LAB – III

S.No.	Name of the Experiment
1	Refractive index of ordinary and extra-ordinary ray using calcite prism
2	Dielectric constant of given material
3	Abbey's Refractometer using different liquids and different concentrations
4	Specific heat of solids
5	Photo elastic constant by Newton's rings
6	Ultrasonic diffraction using quartz crystal
7	Four probe method
8	Planck's constant using LED
9	Diffraction grating using LASER
10	Velocity of ultrasonic waves in organic liquids

Note: Any 8 experiments are to be performed by each student.

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PH3L2 FIBER OPTICS LAB

S.No.	Name of the Experiment
1	Losses in optical fiber at 660nm and 850 nm
2	Characterization of 660nm and 850 nm LEDs
3	Angular misalignment
4	Longitudinal and lateral misalignment losses
5	Characterization of fiber optic phototransistor
6	Measurement of numerical aperture and acceptance angle
7	Setting up of fiber optic voice link
8	Forming PC to PC communication link using optical fiber and RS-232 interface
9	Study of pulse width modulation and demodulation
10	Study of an eye pattern

Note: Any 8 experiments are to be performed by each student

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PH401 PHYSICS OF NANOMATERIALS

UNIT I	**INTRODUCTION TO NANOMATERIALS**
	History, Nanosize and properties, Classification of nanomaterials, Quantum confinement**,** Significance of surface to volume ratio.
UNIT II	**SYNTHESIS OF NANOMATERIALS -1**
	Bottom-up approaches: Physical vapor deposition (PVD), Chemical vapor deposition (CVD),Thermal CVD, Plasma CVD, Laser CVD, Molecular Beam epitaxy (MBE), Sol-gel process, Wet chemical synthesis, Self-Assembly, Physical and chemical self assembly.
UNIT III	**SYNTHESIS OF NANOMATERIALS -2**
	Top-Down approaches: High energy ball milling, Equal channel angular pressing (ECAP), High pressure torsion (HPT), Accumulative roll bonding (ARB), Nanolithography.
UNIT IV	**CHARACTERIZATION OF NANOMATERIALS**
	X-Ray diffraction (XRD), Scanning probe microscopy (SPM), Scanning electron microscopy (SEM), Transmission Electron microscopy (TEM), Scanning tunneling microscope (STM), Atomic force microscopy (AFM), Field ion microscope (FIM).
UNIT V	**APPLICATIONS OF NANOMATERIALS**
	In medicine: Targeted drug delivery, Early diagnosis of disease, In electronics-: Reduction of power computation, Less size and weight components, Smaller & faster processors. In energy: Reduction of cost of catalysts in fuel cells, Increase of solar cell efficiency, Increase energy density of batteries.In space technology: light weight space craft, Reduction in rocket fuel, Larger metals strength, Low temperature, Coefficient of expansion. In automobiles: High strength of material, Increased fuel efficiency, Quality of paints. In environment: Pollution detectors. In textile: Water repellent clothes wrinkle free clothes.

Text Books :	1. Nanoscience & Nanotechnology, by B. S. Murthy, P. Shankar, Balder Raj.
	2. IIM Series in Metallurgy & Materials Science, by B. B. Rath and Tames Murday, University Press.
Reference Books:	1. Nanoparticles – Nanocomposites Nanomaterials- An introduction for beginners.
	2. Essentials of Nanoscience & Nanotechnology, by Katta Narasimha Reddy, Typical Creative’s Nanodigest,1st Edition 2021.
	3.Nanomaterials, by A K Bhandhopadhya,New age International 1st Edition 2007.

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PH402 FIBER OPTIC SENSORS

Unit I	**INTENSITY MODULATED SENSORS**
	General features, Intensity modulation through interruption, Shutter/schliren multimode fiber Optic sensors, Reflective fiber optic sensors, Evanescent – Wave fiber sensors, Microband sensors, Fiber Optic refractometers, Intensity modulated fiber optic thermometers, chemical analysis, Distributed sensing with fiber optics.
Unit II	**INTERFEROMETRIC SENSORS**
	Basic principles of interferometric optical fiber sensors, Applications of interferometric optical fiber sensors, C omponents for interferometric sensors, Future trends in interferometric sensors.
Unit III	**FUSED SINGLE MODE COUPLERS**
	Introduction, Physical principles, polarization effects, Experimental properties- Wavelength dependence, Dependence on external refractive index, Theoretical modeling - Qualitative behavior, First approximation, Second approximation, Comparison with experiment, Dependence on external refractive index.
Unit IV	**SINGLE – MODE ALL FIBER COMPONENTS**
	Directional, couplers, fused single mode couplers, Polished single mode couplers, Polarization splitters, Polarization controllers, Optical isolators, Single mode fiber filters.
Unit V	**SIGNAL PROCESSING IN MONO-MODE FIBER OPTIC SENSOR SYSTEMS**
	Transduction mechanisms – sensor transfer function, Phase modulated sensors, Polarization modulated sensors, Optical processing – Two beam Interferometer, Multiple beam interferometer.

Text Books:	1. Fundamentals of Fiber Optics in Telecommunications and Sensor systems - Edited, by Bishnu P. Pal.
	2. Introduction to Fiber Optics, by Ajoy Ghatak and K. Thyagarajan.
Reference Books:	1. Fiber-Optic Communications Technology, by Djafar K. Mynbaev, Lowell L. Scheiner.

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PH403 NUCLEAR PHYSICS

UNIT I	**NUCLEAR FORCES**
	Introduction, Deuteron problem and its contribution to the definition of nuclear force, Spin dependence of nuclear forces, Effective range theory, Proton – Proton scattering, Non- central forces, Saturation of nuclear forces: Exchange forces and isotopic spin formation, Meson theory of nuclear forces.
UNIT II	**NUCLEAR MODELS**
	Introduction, Liquid drop model, Semi empirical mass formula, Shell model, Predictions of shell model, Magnetic and quadrupole moments, Collective model, Vibrational and rotational states, Unified model and super conductivity model.
UNIT III	**NUCLEAR REACTIONS**
	Classification of nuclear reactions, Kinematics, Neutron spectroscopy, Nuclear cross-section, Partial –wave analysis, Compound nucleus formalism, Nuclear transmutations, Resonance: Breit- Winger dispersion formula.
UNIT IV	**NUCLEAR DECAY AND DETECTION**
	Decay: Range of α-particles, Gamow's theory of α–decay, Probability. Fermi's theory of β-decay, Violation of parity conservation in β-decay. Measurement of γ-ray energies by photodisintegration method. Detection: ionization chamber, Solid state detectors, Scintillation counters, Photomultiplier tube, Cerenkov counter, Nuclear emulsions, Spark chamber.
UNIT V	**ELEMENTARY PARTICLE PHYSICS**
	Classification of elementary particles, Particle interactions, Invariance under charge, Parity – Electrons and positrons, Protons and antiprotons, Neutrons and anti neutrons, Neutrinos and anti neutrinos, Mesons, Hyperons, Hyper nuclei, Resonance states, Elementary particle symmetries, Quark theory.

Text Books:	1. Nuclear Physics, by D.G. Tayal, Himalaya Publishing House.
	2. Nuclear Physics-An introduction, by S. B. Patel , New international (P) Ltd.
Reference Books:	1. Introductory Nuclear Physics, by W.Wong.
	2. Introductory Nuclear Physics, by S.B.Patel.

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PH4E1 PHYSICS OF SOLAR CELLS

Unit I	**SOLAR CELL FUNDAMENTALS**
	The Photovoltaic Effect, Brief History of the Solar Cell, Photovoltaic Cells and power Generation, Photovoltaic cells, Modules and systems, Some important definitions Characteristics of the Photovoltaic Cell: Photocurrent and quantum efficiency, Dark current and open circuit voltage, Efficiency, Parasitic resistances, Non-ideal diode behavior. Basic Principles of PV: Introduction, The Solar resource, Types of Solar energy converter, Detailed balance, In equilibrium, Under illumination, Work available from a photovoltaic device, Photocurrent, Dark current, Limiting efficiency, Effect of band gap, Effect of spectrum on efficiency, Requirements for the ideal Photo-converter.
Unit II	**SEMICONDUCTOR FUNDAMENTALS**
	Drift and Diffusion, Current equations in terms of drift and diffusion, Validity of the drift-diffusion equations, Generation and Recombination : Semiconductor Transport Equations, Quantum Mechanical Description of Transition Rates, Fermi's Golden Rule , Optical processes in a two level system, photo generation, photo generation rate, Thermal ionization, Microscopic description of absorption, Auger recombination, Shockley Read Hall recombination.
Unit III	**SEMICONDUCTOR JUNCTION AND MATERIALS**
	Origin of Photovoltaic Action, Work Function and types of junction, Metal-Semiconductor Junction , Behaviour in the light, Behaviour in the dark , Ohmic contacts, Monocrystalline Solar Cells: Principles of Cell Design, Material and Design issues, Material dependent factors, Design factors, General design features of p-n silicon Material properties, Silicon solar cell design, III –V semiconductor material properties, GaAs solar cell design. Thin Film solar cells: Thin Film photovoltaic Materials, Amorphous Silicon, Amorphous Silicon Solar Cell Design, Amorphous silicon p-i-n structures, $CuInSe_2$ Thin Film Solar Cells, Heterojunctions in thin film solar cell design, $CuInGaSe_2$ solar cell design, CdTe Thin Film Solar Cells.
Unit IV	**MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS**
	PV Modules: IV characteristics of a PV module, maximum power point, cell efficiency, fill factor, effect of irradiation and temperature. Commercial solar cells- Production process of single crystalline silicon cells, multi-crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems and cost estimation

Unit V	**PV SYSTEM APPLICATIONS**
	Classification ,Central Power Station System, Distributed PV System, Stand alone PV system, Grid Interactive PV System, small system for consumer applications, Hybrid solar PV system, Concentrator solar photovoltaic, System components - PV arrays, inverters, batteries, charge controls, net power meters. Building –integrated photovoltaic units, Grid-interacting central power stations, Stand-alone devices for distributed power supply in remote and rural areas, Solar cars, Aircraft, Space solar power satellites. Socio-economic and environmental merits of photovoltaic systems.

Text Books:	1. Solar Photovoltaic: "Fundamentals, Technologies and Application , by Chetan Singh Solanki,PHI Learning Pvt., Ltd.
	2. Solar Cell Technology and Applications, by Jha .A.R, CRC Press.
	3. Introduction to Photovoltaics, by John R. Balfour, Michael L. Shaw, Sharlave Jarosek., Jones & Bartlett Publishers, Burlington.
Reference Books:	1. Concentrator Photovoltaic, by Luque .A. L and Andreev .V.M, Springer.
	2. Solar Energy, by Sukhatme .S.P, Nayak .J.K, Tata McGraw Hill Education Private Limited, New Delhi.

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PH4E3 SYNTHESIS AND CHARACTERIZATION OF MATERIALS

UNIT I	**SYNTHESIS OF MATERIALS**
	Crystal growth, Slow evaporation, Melt growth, Crystal pulling, Zone refining and zone melting, solvothermal methods examples. Synthesis of amorphous materials: Glasses, Polymers, Thin films, Thermal evaporation, e-beam evaporation, DC and RF sputtering, Pyrolysis.
UNIT II	**CHARACTERIZATION METHODS**
	X-ray Crystallography: Introduction, Structure of nanomaterials, X-ray diffraction (XRD) ,The powder method, Determination of grain size/crystallite using X-ray broadening studies (Scherer's formula), Determination of Crystallite size distribution, Small angle X-ray scattering (SAXS).
UNIT III	**CHARACTERIZATION USING MICROSCOPY**
	Characterization methods: Optical Microscopy, Electron Microscopy: Introduction, Working of SEM, TEM, AFM, Particle size determination, energy dispersive spectroscopy, X Ray Fluorescence.
UNIT IV	**ABSORPTION SPECTROSCOPY**
	Spectroscopy Techniques: Introduction, Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy- translational, rotational and vibrational, DSC, UV vis spectroscopy-determination of energy band gap using Tauc plot.
UNIT V	**RESONANCE SPECTROSCOPY**
	Electron Spin Resoanance (ESR), Instrumentation and Spectra analysis, NMR- Bloch's equations, spin-lattice, spin-spin relaxations, Instrumentation, Chemical Shift, Nuclear Quadrupole Resonance(NQR), Electric Field Gradient(EFG) tensor, NQDR.

Text Books:	1. Crystal Growth Processes and Methods, by P. Ramasamy and P. Santhana Raghavan, KRU Publications, Kumbakonam.
	2. Thin Film Phenomena, by Kasturi L. Chopra, Springer.
	3. Elements of X Ray Diffraction, by Cullity, B. D. Publication.
Reference Books:	1. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, McGraw-Hill Book Company.
	2.Elements Of Spectroscopy, by H.V. Sharam,S.L. Gupta,V. Kumar, Pragati Prakashan Publishers.

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PH4E4 ADVANCED INSTRUMENTATION

UNIT I	**TRANSDUCERS**
	Transducers: Classification of transducers, Active and Passive transducers, Electrical transducers, Displacement transducers, Digital transducers, Basic requirement of transducers. Displacement Measurement: Variable resistance devices, Variable inductance devices, Variable capacitance devices. Strain Measurement: Theory of operation of strain gauge, Types of strain gauges, Strain gauge circuits, Quarter bridge, Half bridge and Full bridge, Temperature compensation, Calibration of strains gauges, Strain gauge load cell.
UNIT II	**PRESSURE MEASUREMENT**
	Pressure Measurement: Bourdon Tube, Bellows, Diaphragms, Transduction methods, Potentiometer device, Strain gauge transducer, LVDT type transducer, Variable capacitance device, Force- balance transducer, Piezoelectric transducer, Digital Pressure Transducer, Pressure calibration.
UNIT III	**TEMPERATURE & FLOW MEASUREMENT**
	Temperature Measurement: Classification of temperature measuring devices, Resistance type temperature sensors (platinum resistance thermometer, thermistors), Resistance thermometer circuits, Thermocouples, Types of thermocouples, Cold junction compensation, Solid State Sensors, Temperature measurement by radiation methods, Calibration of thermometers. Flow Measurement: Classification of flow meters, Head type flow meters, Orifice meter, Venturi Tube, Pitot tube, Rota meter-Anemometer, Electromagnetic flow meter, Ultrasonic flow meter.
UNIT IV	**PROCESS CONTROL**
	Process Control: Open loop control, Closed loop control, Examples, Block diagram algebra, Block diagram of Closed loop system ,Closed loop transfer function, DC and AC Servomotors, Stepper motor, Temperature Control, Liquid level control. Analog and Digital Data Acquisition Systems: Interfacing transducers to electronic control and measuring systems, Digital to analog multiplexer, Analog to Digital multiplexer, IEEE 488 Bus.
UNIT V	**DATA TRANSMISSION AND TELEMETRY**
	Data Transmission and Telemetry : Methods of data transmission, General telemetry system-Functional blocks of telemetry system, Types of telemetry system, Land line telemetering system, Voltage telemetering systems, Current telemetering system, Position telemetering system, Land line telemetry feedback system, Radio frequency telemetry, PAM, PCM Telemetering, Multiplexing in telemetering system, Transmission channels, Digital data transmission.

Text Books:	1. Modern Electronic Instrumentation and Measurement Techniques, by A.O.Helfrick and W.D.Cooper, Prentice Hall India Publications.
	2. Instrumentation Devices and Systems, by C.S.Rangan, G.R. Sharma and VSV Mani, Tata Mc.Graw Hill Publications.
Reference Books:	1. Introduction to instrumentation and Control, by A.K.Ghosh,Prentice Hall India Publications.
	2. Electrical and Electronics Measurement and Instrumentation, by A.K.Sawh.

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PH4L1 NANOMATERIALS LAB

S.No.	Name of the Experiment
1	Synthesis of CuO nanoparticles using Glycine as fuel by Solution combustion method
2	Synthesis of CuO nanoparticles using Ascorbic acid as fuel by Solution combustion method
3	Verification of BEER-LAMBERT's law using colorimeter
4	Preparation of Cobalt nanoparticles by wet chemical reduction method
5	Synthesis of ZnO nanoparticles using Glycine as fuel by Solution combustion method
6	Synthesis of ZnO nanoparticles using Ascorbic acid as fuel by Solution combustion method
7	Synthesis of silica gel (SiO_2) using SOL-GEL method
8	Preparation of Gold nanoparticles by wet chemical reduction method
9	Synthesis of PVP capped Cadmium Sulfide (CdS) nanoparticles by chemical Co-precipitation method
10	Conductometry

Note: Any 8 experiments are to be performed by each student