

DEPARTMENT OF PHYSICS
Faculty of Natural Science
Jamia Millia Islamia, New Delhi

Details of subjects required for online exam forms: Even Semester 2016-17

Name of the Department : Physics

Whether CBCS structure followed : Yes, Followed

B.Sc. Physics (Hons.)

S.No	Title of Paper	Paper type	Paper Code	Credit	Maximum Marks (Internal Assessment)	Maximum Marks (University Exam.)
Semester-II						
1	Thermal Physics	Core	PHB 21C	3	25	75
2	Oscillation and Waves	Core	PHB 22C	3	25	75
3	Development of Modern Physics (Choice Based Elective)	CBCS	PHB 21E	4	25	75
4	Lab II	Lab.	PHB 21L	2	50	50
Semester- IV						
1	Electricity & Magnetism II	Core	PHB 41C	3	25	75
2	Quantum Mechanics	Core	PHB 42C	3	25	75
3	Mathematical Physics II	Core	PHB 43C	4	25	75
4	Properties of Matter (Choice Based Elective)	CBCS	PHB 41E	4	25	75
5	Lab IV	Lab.	PHB41L	2	50	50

Semester-VI (Non CBCS System)						
1	Solid State Physics-II	Core	PHB-601	-	25	75
2	Atomic & Molecular Physics	Core	PHB-602	-	25	75
3	Nuclear and Particle Physics	Core	PHB-603	-	25	75
4	Semiconductor Physics	Core	PHB-604	-	25	75
5	Advanced Optics	Core	PHB-605	-	25	75
6	Lab VI	Lab	PHB-611	-	50	50

B. Sc. (Subsidiary/Other Disciplines):

S.No.	Title of Paper	Paper type	Paper Code	Credit	Maximum Marks (Internal Assessment)	Maximum Marks (University Exam.)
Semester-II						
1	Thermal Physics	Core	PHB-21S	3	25	75
2	Lab II	Lab.	PHB-23L	1	50	50
Semester-IV						
1	Quantum Mechanics	Core	PHB-41S	3	25	75
2	Lab IV	Lab.	PHB-43L	1	50	50

B.Sc. (Pass/Inst.):

S.No.	Title of Paper	Paper type	Paper Code	Credit	Maximum Marks (Internal Assessment)	Maximum Marks (University Exam.)
Semester – II						
1	Thermal Physics	Core	PHB-21P	3	25	75
2	Lab II	Lab.	PHB-22L	1	50	50

Semester – IV						
1	Electricity & Magnetism II	Core	PHB-41P	3	25	75
2	Quantum Mechanics	Core	PHB-42P	3	25	75
3	Lab IV	Lab.	PHB-42L	2	50	50
Semester-VI (Non CBCS System)						
1	Atomic & Molecular Physics	Core	PHB-606	-	25	75
2	Nuclear and Particle Physics	Core	PHB-607	-	25	75
3	Lab VI	Lab.	PHB-612	-	50	50

M.Sc. Physics (Semester - II) :

S.No.	Title of Paper	Paper type	Paper Code	Credit	Maximum Marks (Internal Assessment)	Maximum Marks (University Exam.)
1.	Condensed Matter Physics I	Core	PHM-21C	4	25	75
2.	Quantum Mechanics II	Core	PHM-22C	4	25	75
3.	Electrodynamics	Core	PHM-23C	4	25	75
4.	Mathematical Physics II (Choice Based Elective)	CBCS	PHM-21E	4	25	75
5.	Numerical Analysis and Programming (Skill Enhancement Course)	SEC	PHM-21A	4	25	75
6.	Lab II	Lab.	PHM-21L	4	50	50

M.Sc. Physics (Semester - IV) :

S.No.	Title of Paper	Paper type	Paper Code	Credit	Maximum Marks (Internal Assessment)	Maximum Marks (University Exam.)
1.	Statistical Mechanics	Core	PHM 41C	4	25	75
2.	Advanced Topics in Material Science	CBCS	PHM 41E	4	25	75
3.	Characterization of Materials	CBCS	PHM 42E	4	25	75
4.	Physics & Technology of Semiconductor Devices	CBCS	PHM 43E	4	25	75
5.	Photonics	CBCS	PHM 44E	4	25	75
6.	Quantum Optics	CBCS	PHM 45E	4	25	75
7.	Laser Spectroscopy	CBCS	PHM 46E	4	25	75
8.	General Relativity	CBCS	PHM 47E	4	25	75
9.	Particle Physics	CBCS	PHM 48E	4	25	75
10.	Quantum Field Theory	CBCS	PHM 49E	4	25	75
11.	Project	Project	PHM 42C	4	50	50

M.Sc.

Sl. No.	Name of the Paper	Paper Type	Paper Code	Credits	Periods/week
<i>Semester I</i>					
1	Quantum Mechanics I	Core	PHM11C	4	4
2	Mathematical Physics I	Core	PHM-12C	4	4
3	Classical Mechanics	Core	PHM-13C	4	4
4	Electronics	CBE	PHM-11E	4	4
5	Lab I	Lab	PHM-11L	6	12
<i>Semester II</i>					
1	Condensed Matter Physics I	Core	PHM-21C	4	4
2	Quantum Mechanics II	Core	PHM-22C	4	4
3	Electrodynamics	Core	PHM-23C	4	4
4	Mathematical Physics II	CBE	PHM-21E	4	4
5	Experimental Techniques	SEC	PHM-21A	4	4
6	Lab II	Lab	PHM-21L	6	12
<i>Semester III</i>					
<i>Material Science Specialization</i>					
1	Atomic & Molecular Physics	Core	PHM-31C	3	3
2	Nuclear & Particle Physics	Core	PHM-32C	3	3
3	Advanced Topics in Material Science	Core	PHM-33CM	4	4
4	Lab III	Lab	PHM-31L	6	12
5	Numerical Analysis & Programming	AEC	PHM-31A	4	4
<i>Laser & Spectroscopy Specialization</i>					
1	Atomic & Molecular Physics	Core	PHM-31C	3	3
2	Nuclear & Particle Physics	Core	PHM-32C	3	3
3	Laser Physics	Core	PHM-33CL	4	4
4	Lab III	Lab	PHM-31L	6	12
5	Numerical Analysis & Programming	AEC	PHM-31A	4	4
<i>Theory Specialization</i>					
1	Atomic & Molecular Physics	Core	PHM-31C	3	3

2	Nuclear & Particle Physics	Core	PHM-32C	3	3
3	Classical Field Theory	Core	PHM-33CT	4	4
4	Lab III	Lab	PHM-31L	6	12
5	Numerical Analysis & Programming	AEC	PHM-31A	4	4
<i>Electives</i>					
6	Characterization of Materials	CBE	PHM-31E	4	4
7	Photonics	CBE	PHM-32E	4	4
8	General Relativity	CBE	PHM-33E	4	4
<i>Semester IV</i>					
<i>Material Science Specialization</i>					
1	Statistical Mechanics	Core	PHM-41C	4	4
2	Condensed Matter Physics II	Core	PHM-42C	4	4
3	Phys &Tech of Semiconductor Devices	Core	PHM-43CM	4	4
4	Project	Project	PHM-44	4	
<i>Laser & Spectroscopy Specialization</i>					
1	Statistical Mechanics	Core	PHM-41C	4	4
2	Condensed Matter Physics II	Core	PHM-42C	4	4
3	Quantum Optics	Core	PHM-43CL	4	4
4	Project	Project	PHM-44C	4	
<i>Theory Specialization</i>					
1	Statistical Mechanics	Core	PHM-41C	4	4
2	Condensed Matter Physics II	Core	PHM-42C	4	4
3	Particle Physics	Core	PHM-43CT	4	4
4	Project	Project	PHM-44C	4	
<i>Electives</i>					
5	Physics of Novel Materials	CBE	PHM-41E	4	4
6	Laser Spectroscopy	CBE	PHM-42E	4	4
7	Quantum Field Theory	CBE	PHM-43E	4	4

Semester I

Core Course

Quantum Mechanics I

PHM-11C

Unit I: Mathematical Tools

Brief introduction to origins of quantum Physics. Wave packets. Dirac notation. Operators, their eigenvalues and eigenfunctions, orthonormality, completeness and closure. Generalized uncertainty principle. Unitary transformations, change of basis. Matrix Representation of operators. Continuous basis, position and momentum representation and their connection. Parity operator.

Unit II: Fundamental Concepts of Quantum Mechanics

Basic postulates of quantum mechanics. Measurement. Time evolution of system's state. Schrödinger, Heisenberg and interaction pictures. Density operator. Pure state and mixed state density operators. Discrete and continuous spectra in 1-D. Solution of 1-D harmonic oscillator using algebraic method.

Unit III: Angular Momentum

Orbital, Spin and total angular momentum operators. Pauli spin matrices, their Commutation relations. Eigenvalues and eigenfunctions of L^2 and L_z . Angular momentum as generator of rotation. Addition of angular momenta. Clebsch-Gordon coefficients. L-S coupling.

Unit IV: Identical Particles

Many particle systems, systems of identical particles, exchange degeneracy, symmetrization postulate, construction of symmetric and anti-symmetric wave functions from unsymmetrized functions. The Pauli exclusion principle. Introduction to second quantization. Creation and annihilation operators for Fermions and Bosons. Fock states.

Reference Books:

1. Quantum Mechanics : N. Zettili
2. Quantum Mechanics : Franz Schwabl
3. Modern Quantum Mechanics : J.J.Sakurai
4. Principles of Quantum Mechanics : P. A. M. Dirac
5. Quantum Mechanics : Bohm

Semester I

Core Course

Mathematical Physics I

PHM-12C

Unit I: Complex Analysis

Advanced complex analysis : Brief description of functions of complex variables with examples, mappings, limits, continuity, differentiation, analytic functions, branch cut, branch point, line integral, simply and multiply connected domains, Taylor and Laurent series : convergence, residues and poles, contour integrals, 2-dimensional Laplace equation

Unit II: Partial Differential Equations

Partial differential equations : 1-dimensional - vibrating string, heat flow, 2-dimensional - vibrating membrane, 3-dimensional – Wave equation, Laplace equation : potential theory, diffusion equation

Unit III: Green's Function

Green's function : Method for boundary value problems, GF in one dimension, eigenfunction expansion of Green's function, multidimensional GF's, examples : elliptic, parabolic and hyperbolic equations

Unit IV: Integral equations

Integral equations : Classification, Fredholm and Volterra integral equations, Transformation of a differential equation into integral eq., Hermitian Kernel, degenerate kernels, Fredholm alternative, integral transforms, successive approximations, successive substitution, resolvent kernel, Hilbert-Schmitt theory

Unit V: Tensor Analysis

Contravariant vectors, Covariant vectors, Coordinate transformation from one coordinate system to another, Various coordinate systems (Cartesian, Cylindrical, Spherical Polar, Oblique axes etc.), Addition and subtraction of tensors, symmetric/anti-symmetric tensor, outer multiplication, contraction, inner multiplication, quotient theorem. Inertia tensor, definition, derivation of expression, calculation of it's components, stress, strain and elastic constant tensors, Christoffel symbols, Riemann curvature tensor

Reference Books:

1. Complex variables and applications by Churchill & Brown, IV Ed, MGH
2. Mathematical Physics, Sadri Hassani, II Ed., Springer
3. Mathematical methods for physicists, 6th Ed., Arfken& Weber, Elsevier
4. Tensors by De, Sheikh and Sengupta, Narosa.

Semester I

Core Course

Classical Mechanics

PHM-13C

Unit I: Lagrangian Formalism

Newtonian mechanics and its limitations. Constrained motion. Constraints and their classification. Principle of virtual work. D' Alembert's principle. Generalised coordinates. Deduction of Lagrange's equations from D' Alembert's Principle. Generalised momenta and energy. Cyclic or ignorable coordinates. Rayleigh's dissipation function. Integrals of motion. Symmetries of space and time with conservation laws.

Unit II: Hamiltonian formalism

Principle of least action. Hamilton's principle. The calculus of variations. Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle. Hamilton's principle and characteristic functions.

Unit III: Canonical Transformation

Canonical Transformations. Generating functions. Poisson bracket. Poisson's Theorem. Invariance of PB under canonical transformations. Angular momentum PBs. Hamilton-Jacobi equation. Connection with canonical transformation. Problems.

Unit IV: Rigid Body Dynamics

Rotational motion, moments of inertia, torque. Euler's theorem, Euler angles. Symmetric top. Gyroscopes and their applications.

Unit V: Small Oscillations and Nonlinear Dynamics

Small Oscillations. Normal modes and coordinates. Applications. Perturbations and KAM theorem, Attractors, Chaotic trajectories and Liapunov exponents, Poincare maps, bifuractions, Logistic equation, Fractals and dimensionality

Reference Books:

1. Classical Mechanics: H. Goldstein.
2. Mechanics: L. D. Landau and E. M. Lifshitz
3. Classical Mechanics: N.C.Rana and P.S.Joag.
4. Theoretical Mechanics: Murray Spiegel.
5. Classical Mechanics Systems of Particles and Hamiltonian Dynamics:Walter Greiner

Semester I

Choice Based Elective

Electronics

PHM-11E

Unit I: Semiconductor Devices I

Semiconducting Materials, conduction in semiconductors, Charge densities in a semiconductors, PN junction, space charge and electric field distribution at junctions, forward and reverse biased conditions, Space charge capacitance, varactor diode, Zener and avalanche breakdowns, zener diode, tunnel diode, photodiode, LED, p-n-p-n devices and their characteristics, SCR.

Unit II: Semiconductor Devices II

Transistors: Bipolar junction Transistor (BJT), Ebers Moll Model, Analysis of CE amplifier using h-parameters, The T-network equivalent circuit, constants of CB and CE amplifier using emitter, base, collector resistance, Biasing technique to BJT, stabilization factor, temperature stabilization, operating point, fixed bias, emitter feedback bias, voltage feedback bias. Field-Effect Transistors (FET) and MOSFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions.

Unit III: Feedback Principle

Negative feedback, effect of negative feedback on input/output resistances and voltage gain, gain stabilization, effect of negative feedback on band width, voltage series feedback, voltage shunt feedback applied to BJT, current series feedback, current shunt feedback applied to BJT

Unit IV: Microwave Electronics

Microwaves, Principle of velocity modulation and bunching of electrons, Basic principles of two cavity klystrons and Reflex Klystrons, operation of magnetrons, characteristics of microwave diode.

Reference Books:

1. Electronic Fundamentals and Applications : John D. Ryder
2. Electronic Devices and Circuits : Millman and Halkins
3. Solid State Electronic Devices : Ben G. Streetman
4. Electronics : Ramabhadran S.
5. Electronics Devices and Circuit theory : Boylested and Nashelsky
6. Pulse, Digital and Switching Waveforms : Millman and Taub
7. Fundamental of Transistor : S.W. Amos
8. Microwave Principle : W.J. Reich
9. Microwaves : K.L. Gupta
10. Introduction to Microwave : G.J.Wheeler;
11. Semiconductor Devices- Physics and Tecnology : S.M. Sze.

Semester I

Physics Practical

Lab I

PHM-11L

List of Experiments :

1. PN Junction : To find the band gap of the semiconductor
2. CE Amplifier (Bread Board) : To find bandwidth of capacitive coupled common emitter amplifier
3. Transistor Biasing : To study various biasing techniques, viz i) self bias ii) fixed bias, iii) voltage divider biasing, and to find the best biasing by observing the temperature effect on output waveform
4. FET : To find input and transfer characteristics of Field Effect Transistor
5. MOSFET : To find input and transfer characteristics of MOSFET
6. Op-Amp : To make inverting/non-inverting amplifiers, buffer, integrator and differentiator circuits using operational amplifier
7. To study Feedback in Transistors : a) series-series b) series-shunt c) shunt-series iv) shunt-shunt feedbacks
8. IC555 (BB) : To make astable and monostable vibrator using IC555
9. Phase Shift Oscillator (BB) : To make RC phase shift oscillator using 3 and 4 RC networks and compare experimental and theoretical frequencies
10. To study Amplitude Modulation & Demodulation and to calculate modulation index
11. To make Astable multivibrator using bipolar transistor
12. Optoelectronic kit : to study characteristics of i) Light Emitting Diode, ii) Temperature Dependent Resistance, iii) light dependent transistor
13. To study Analog to Digital conversion
14. To study Digital to Analog conversion
15. To study Frequency Modulation & Demodulation and to calculate modulation index
16. To study PAM (Pulse Amplitude Modulation) circuit
17. To study PCM (Pulse Code Modulation) circuit
18. To study PWM (Pulse Width Modulation) and PPM (Pulse Position Modulation) circuits

Semester II

Core Course

Condensed Matter Physics I

PHM-21C

Unit I: Bonding in crystals

Covalent, ionic, metallic, hydrogen bond, van der Waal's bond and the Madelung constant. Crystalline solids, unit cell, primitive cell, Bravais lattices, Miller indices, closed packed structures. Atomic radius, lattice constant and density. Connection between orbital symmetry and crystal structure. Scattering from periodic structures, reciprocal lattice, Brillouin Zones.

Unit II: Phonons - Lattice Dynamics and Thermal Properties.

Lattice dynamics of atoms in crystals, vibrations of monoatomic and diatomic linear chains, acoustic and optical phonon modes, density of states, thermal properties of crystal lattices, thermal energy of the harmonic oscillator, specific heat capacity of the lattice, Debye theory of specific heats.

Unit III: Free Electron Theory

Free electrons in solids, density of states, Fermi surface, Fermi gas at $T=0$ K, Fermi statistics, specific heat capacity of electrons in metals, thermionic emission of electrons from metals.

Unit IV: Electronic Band Structure

Electronic band structure in solids, Electrons in periodic potentials, Bloch's Theorem, Kronig-Penney model, Nearly free electron model, Tight-binding model : density of states, examples of band structures. Fermi surfaces of metals and semiconductors.

Unit V: Transport properties

Motion of electrons in bands and the effective mass, currents in bands and holes, scattering of electrons in bands, Boltzmann equation and relaxation time, electrical conductivity of metals, thermoelectric effects, the Wiedemann-Franz Law.

Reference Books:

1. Solid State Physics : Hook and Hall : Hook and Hall
2. Introduction to Solid State Physics : Kittel
3. Solid State Physics : Ibach and Luth
4. Introduction to the Theory of Solids : H. M. Rosenberg
5. Solid State Physics : Blakemore
6. Solid State Physics : Ashcroft and Mermin

Semester II

Core Course

Quantum Mechanics II

PHM-22C

Unit I: Approximation methods for stationary systems

Time independent perturbation theory. Perturbation of non-degenerate states: first and second order perturbation. Perturbation of a harmonic oscillator. Perturbation of degenerate states, removal of degeneracy. Zeeman and Stark effects. Variational and WKB methods.

Unit II: Approximation methods for non-stationary systems

Schroedinger, Heisenberg and interaction pictures, Equations of Motion. Constant and harmonic perturbation. Discrete and continuous case, transition probability. Fermi golden rule. Adiabatic and sudden approximations.

Unit III: Scattering Theory

Scattering of a wave packet. The differential and total Cross section. The Born approximation. Partial waves and phase shifts. The Lippmann Schwinger equation. Definition and properties of S-matrix, T matrix. Optical theorem

Unit IV: Relativistic Quantum Mechanics

Klein-Gordon and Dirac equations, properties of Dirac matrices. Lorentz and CPT invariance of Dirac equation. Non-relativistic reduction of the Dirac equation. Central forces and the hydrogen atom.

Unit V: Solution to Dirac Equation

Free particle solution, hydrogen atom in Dirac's theory, Dirac electron in constant magnetic field, Foldy-Wouthuysen transformation, Hole theory.

Reference Books :

1. Quantum Mechanics : Franz Schwabl
2. Quantum Mechanics : Eugen Merzbacher
3. Quantum Mechanics : N. Zettili
4. Quantum Mechanics : P. M. Mathews and K. Venkatesan
5. Principles of Quantum Mechanics : P. A. M. Dirac

Semester II

Core Course

Electrodynamics

PHM-23C

Unit I: Electrodynamics : Potential formulation and Conservations laws

Review of Maxwell's equations. Scalar and vector potentials. Gauge transformations. Coulomb and Lorentz Gauge, Conservation of energy and momentum, Poynting's theorem, Maxwell's Stress tensor.

Unit II: Wave equation: retarded solutions

Inhomogeneous wave equations, Green's functions for Poisson, Helmholtz and Wave equations. Retarded and Advanced solutions for Maxwell's equations. Jefimenko formulas for fields for charge and current distributions.

Unit III: Radiation by moving charge

Lienard-Wiechert Potentials. Electromagnetic field of a moving point charge. Radiation from an accelerated charge, Larmor's formula and Lienard's generalization (relativistic); Angular distribution of radiated power for linearly and circularly accelerated charges, Bremsstrahlung, Synchrotron, Cherenkov radiation (qualitative treatment only).

Unit IV: Radiation damping

Radiation reaction from energy conservation, Abraham-Lorentz formula, Self force.

Unit V: Relativistic Electrodynamics

Review of STR. Lorentz transformations. Electromagnetic field tensor, Transformation of electromagnetic fields, Covariant formulation of electrodynamics. Field due to a point charge in uniform motion, Energy-momentum tensor and the conservation laws for the electromagnetic field; the equation of motion of a charged particle in an electromagnetic field; Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.

Reference Books:

1. Classical Electrodynamics : J.D. Jackson,
2. Classical Theory of Fields : Landau & Lifshitz
3. Introduction to Electrodynamics: D. J. Griffiths
4. Foundations of Electromagnetic Theory : Reitz, Milford and Christy
5. Classical Charged Particle : Rohrlich

Semester II

Choice Based Elective

Mathematical Physics II

PHM-21E

Unit I: Vector spaces

Linear vector spaces : Vector spaces, inner product spaces, Cauchy sequence: eigenvalues, diagonalization and spectral theory , direct sum and product of matrices, Hilbert space : properties, function spaces, dual space, direct sum of function spaces, operators.

Unit II: Discrete groups

Discrete Groups : examples, multiplication table, conjugate elements and classes, subgroups, normal subgroups, factor groups, direct product of groups, isomorphism & homomorphism, group of symmetries of regular polygon, permutation groups,

Unit III: Representation of groups

Invariant subspaces and reducible representations, Schur's lemmas and the orthogonality theorem, characters of a representation, regular representation, symmetrized basis functions for irreducible representation, transfer and projection operators, direct product of representations, representations of a direct product group, examples

Unit IV: Continuous groups

Continuous groups : Topological groups and Lie groups, axial rotation group $SO(2)$, 3-D rotation group $SO(3)$, Lorentz group, Special Unitary group $SU(2)$, generators of $U(n)$ and $SU(n)$, Lie algebra and representations of Lie group, Special Unitary group $SU(3)$, examples

Unit V: Permutation groups

Permutation group, disjoint and non-disjoint cycles, transpositions, parity, generators, classes, character table, representations, partitioning of n , Young diagrams, Young tableau

Reference Books:

1. Elements of group theory for physicists, 4th Ed., A W Joshi, New Age Int.
2. Group Theory by Abbas, Taylor & Francis
3. Mathematical methods for physicists, 6th Ed., Arfken & Weber, Elsevier
4. Group Theory by Hamermesh
5. Mathematical Physics, by Sadri Hassani, II Ed., Springer

Semester II

Ability Enhancement course

Experimental Techniques

PHM-21A

Unit I: Basic Data processing

Recording and analysis of data, data uncertainty, Error: - accuracy and precision, computer-aided data acquisition

Unit II: Introduction to Vacuum

Fundamentals of Vacuum, Gas Flow Mechanism, Concept of Throughput and Pumping Speed, Various types of Pumps - Pressure Measurements gauges, valves, seals - Leak Detection techniques

Unit III: Thin Film deposition

Physical vapour deposition, thermal evaporation, e-beam evaporation, sputtering, pulsed laser deposition, molecular beam epitaxy, MOCVD.

Unit IV: Single Crystal growth

Bridgman-Stockbarger and Czochralski method, flux and hydrothermal method, purification of materials, zone refining.

Reference Books:

1. Vacuum Technology: Alexander Roth
2. The Growth of Single Crystals : R.A. Laudise
3. The Art & Science of Crystal Growth : J.J. Gilman.
4. Material Science and Engineering : V. Raghavan
5. Essentials of Crystallography : M.A. Wahab
6. Crystal growth for beginners : Ivan Markov
7. Physics of Crystal Growth: Alberto Pimpinelli and Jacques Villain

Semester II

Physics Practical

Lab II

PHM-21L

List of Experiments :

1. Study of radioactivity by using a G.M. tube to (i) Determine background radiation and (ii) Study absorption in air of β and γ radiation from ^{137}Cs and ^{60}Co sources.
2. Hall effect : Study of the dependence of Hall coefficient on temperature.
3. Determination of the magnetic susceptibility of MnCl_2 by Quincke's tube method.
4. Study of magnetoresistance of doped semiconductors.
5. Study of magnetic hysteresis in various ferromagnetic materials using a Hysteresis loop tracer .
6. Frank- Hertz experiment.
7. Determination of the dissociation energy of Iodine molecule.
8. Fourier analysis of sinusoidal, triangular and square waveforms.
9. Determination of the Curie temperature of ferroelectric materials.
10. Determination of the forbidden energy gap of semiconductors.
11. Determination of the e/m ratio of electrons by Thomson's method using a fine beam electron tube and Helmholtz coils.
12. Determination of the dielectric constants of amorphous and crystalline solids.
13. Determination of the Landé g factor of electrons using ESR.
14. Determination of ultrasonic velocity in liquids.
15. Study of the temperature dependence of resistivity of semiconductors by the 4-probe method.
16. Study of I-V characteristics, and determination of the fill-factor and efficiency of a solar photovoltaic cell.
17. Study of Zener and avalanche breakdown in P-N junction diodes as a function of Temperature.

Semester III

Core Course

Atomic & Molecular Physics

PHM-31C

Unit I: Basic Concepts

Review of Solution of Schroedinger's equation for Coulomb field and Hydrogen atom, dipole approximation, spectroscopic terms and selection rules, intensities of spectral lines.

Unit II: Interaction with Electromagnetic Field

Fine structure of Hydrogen like atoms: spin-orbit interaction, relativistic correction, Lamb shift. Interaction with external fields: Zeeman, Paschen-Back and Stark effects.

Unit III : Atomic Spectra

The LS-coupling approximation, J-J coupling, hyperfine structures. The central field approximation, Thomas Fermi-potential, alkali atom spectra, Na doublet.

Unit IV: Molecular Spectra

Born-Oppenheimer Approximation, Rotational, Vibrational, Rotational-Vibrational and Electronic spectra of Di-atomic molecules, Selection rules, Frank-Condon principle, Raman spectra, NMR, ESR.

Reference Books:

1. Physics of Atoms and Molecules : B.H. Bransden & C.J. Joachain
2. Elementary Atomic Structure : G.K. Woodgate
3. Introduction to Modern Physics : H.S. Mani & G.K. Mehta
4. Molecular Spectra : G. Herzberg
5. Fundamentals of Molecular Spectroscopy : C.N. Banwell

Semester III

Core Course

Nuclear & Particle Physics

PHM-32C

Unit I: Basic Nuclear Concepts

Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Energy levels and mirror nuclei.

Unit II: Nuclear Forces

Characteristics of nuclear forces -Range and strength, Simple theory of two nucleon system - deuterons, Spin states of two nucleon system, Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces.

Unit III : Energy deposition and Particle detection

Interaction of charged particles with matter. Stopping power and range. Detectors for energetic charged particles; Solid State or Semiconductor detector.

Unit IV: Particle Accelerators

Need for accelerator of charged particles, Classification of types of accelerators, Proton Synchrotron, Betatron; Alternating gradient accelerator, Colliding beam accelerator.

Unit V: Elementary particles

Classification and properties of elementary particles; Resonances ; Interactions and their mediating quanta, Conservation rules in fundamental interactions; Strangness and associated production, Isospin and its conservation. Parity and charge conjugation, Conservation of parity and its violation Idea of eight fold way and quarks.

Reference Books:

1. Nuclei and Particles : Segre
2. Nuclear Physics : Cohen
3. Nuclear Physics : Enge
4. Physics of Nuclei and Particles : Marmur and Sheldon
5. Introduction to Nuclear and Particle Physics : Das and Ferbel

Semester III

Core Course

**Advanced Topics
in Material Science**

PHM-33CM

Unit I: Crystal structure, symmetry and electronic energy levels

Review of bonding in solids and electronic structure, link between valence electronic states and crystal symmetries, density of states for metals, semiconductors and insulators, dispersion of electron energy levels, van Hove singularities, energy bands, Fermi surfaces, De Haas - van Alphen effect.

Unit II: Experimental determination of electronic structure

X-ray and ultraviolet photoelectron spectroscopies and Auger electron spectroscopy. Chemical shift determination. Calculation of electronic energy levels and their dispersion, using angle-resolved photoemission spectra.

Unit III: Density Functional Theory

Extension of Central Field Approximation, Hohenberg-Kohn Theorems, statement and proof. Kohn Sham orbitals, pseudo potentials, the self-consistent field method for the calculation of ground state energies in DFT.

Unit IV: Crystal growth and defects

Kinetics of Crystal Growth: homogenous and heterogenous nucleation, diffusion and screw dislocation mechanism of crystal growth. Atomic imperfections in crystals- one, two and three dimensional imperfections, Schottky and Frenkel defects, Burger's vector and Burger's circuit, energy of dislocations, grain boundaries and surface reconstructions.

Reference Books:

1. Intro. To Solid State Physics: Chales Kittel
2. Solid State Physics : Ibach & Luth
3. Quantum Theory of Solids : Charles Kittel
4. Solid State Physics: Ashcroft and Mermin
5. Experimental Techniques of Surface Science : Woodruff and Delchar
6. Density Functional Theory: Kieron Burke.
7. Electronic Structure: Richard M. Martin
8. Crystal growth for beginners : Ivan Markov
9. Physics of Crystal Growth: Alberto Pimpinelli and Jacques Villain
10. Material Science and Engineering : V. Raghavan

Semester III

Core Course

Laser Physics

PHM-33CL

Unit I: Optical Resonators and Gaussian Beam

Brief review of matrix optics, Planar Mirror Resonators, Resonator Modes, Two- and Three-Dimensional Resonators, Spherical-Mirror Resonators, Ray confinement, Gaussian waves and its characteristics: The Gaussian beam, Transmission through optical component, Gaussian Modes, Resonance Frequencies, Hermite-Gaussian Modes, Finite Apertures and Diffraction Loss.

Unit II: Photons and Atoms

The Photon Optics theory of light in a resonator, Photon Polarization, Transmission and interference of photon, Photon time, Photon streams. Energy levels and Occupation of energy levels in thermal equilibrium, Interaction of single mode light with an atom, Spontaneous Emission, Transition Probabilities, Stimulated Emission and absorption, line shape function, Transition in presence of broadband light, Lineshape broadening: Homogeneous and Inhomogeneous Broadening. Lifetime broadening, Collision Broadening, Doppler Broadening.

Unit III : LASER Amplifiers

Theory of laser amplifiers, Gain and band width, Phase shift, Rate equations, pumping schemes, Common Laser amplifiers, Doped glass amplifiers, Amplifier Nonlinearity and stability saturation-saturated gain in homogeneously and inhomogeneously broadened media. Amplifier noise.

Unit IV: Lasers

Theory of laser oscillation, Optical amplification and feedback, Condition for laser oscillation, Characteristics of laser output, Mode selection, Common lasers; Selected characterises of common lasers, Pulsed lasers: Methods of pulsing lasers, Q-switching, Mode locking.

Reference Books:

1. Introduction to Laser Physics : K.Shimoda
2. Principles of Lasers : O. Svelto
3. Lasers- Theory and Applications : Thyagarajan and Ghatak
4. Fundamentals of Photonics: B.E.A. Saleh and M.C. Teich

Semester III

Core Course

Classical Field Theory

PHM-33CT

Unit I: Review of Classical Physics

Hamiltonians and Lagrangians. Legendre transforms and their properties. Euler-Lagrange equations. Principle of least action. (Functional calculus.) What is classical field theory? Group theory from invariances of classical equations. Newton's equations and the Galilean group. Maxwell's equations. Special Relativity and the Lorentz group. Vectors and tensors of the rotation and Lorentz groups.

Unit II: Basics of CFT

Systems with infinite degrees of freedom. Locality in space and time. Lagrangian densities for real and complex scalar fields. Euler-Lagrange (EL) equations. Functional calculus revisited. Hamiltonian density. The energy-momentum tensor. Finite-energy time-independent solutions -- classical vacua. Kinks in the Sine-Gordon and ϕ^4 theories. Green functions as singular solutions. Boundary conditions.

Unit III: Symmetries : Secret Symmetry and Local Symmetries

Discrete and continuous symmetries. Noether's theorem: the energy momentum tensor, the generalized angular momentum and the electromagnetic current. (Lie groups and Lie algebras. Representations of groups.) Global symmetries. Spontaneous breakdown of symmetry. Goldstone's theorem. (Coset spaces in group theory.) Abelian gauge fields. Covariant derivatives and minimal coupling. The abelian Higgs model. Vortex solutions (in type II superconductors). Topological conservation laws. The abelian Higgs mechanism.

Unit IV: The massless vector field

The Lagrangian density. Gauge invariance and the electromagnetic field strength. Maxwell's equations. Lorentz invariants of the field strength. The symmetrized energy-momentum tensor. The generalized angular momentum and the spin of the photon.

Unit V: Solitons and Instantons

Solitons as finite-energy solutions. Derrick's theorem. Getting around Derrick's theorem. Local symmetries and gauge fields. Abelian vortices. The Dirac monopole as a singular solution of Maxwell's equations. Dirac quantization. Instantons as finite action solutions to the EL equations. The 't Hooft solution. Nahm and Bogomolnyi equations from dimensional reduction.

Reference Books:

1. The Classical Theory of Fields : L. D. Landau and E. M. Lifshitz.
2. Classical Fields : M. Carmeli,
3. Electrodynamics and Classical Theory of Fields : A. O. Barut,
4. Aspects of Symmetry : S. Coleman,
5. Solitons and Instantons: R. Rajaraman

Semester III

Choice Based Elective

**Characterization of
Materials**

PHM-31E

Unit I: Optical methods of structure determination

Optical microscopy, Raman spectroscopy, UV-Vis absorption spectroscopy, FTIR spectroscopy, Photoluminescence

Unit II: Determination of Surface Structure

Microscopy techniques: SEM, AFM, TEM, STM. Electron Diffraction techniques : Low Energy Electron Diffraction, Reflection High Energy Electron Diffraction.

Unit III: Surface analytical techniques for electronic structure

Auger electron spectroscopy, X-Ray photoelectron spectroscopy, SIMS, Rutherford backscattering

Unit IV: X-Ray Diffraction Studies

Diffraction phenomena as applied to Solid State problems, scattering and absorption of X-rays, neutrons and electrons. X-ray method for orienting crystals. Applications of XRD. Diffraction from regular and faulted closed packed structures. Broadening of diffraction spots due to defects. Line profile analysis, crystal structure analysis, measurement of intensities of X-ray reflection.

Reference Books:

1. Experimental techniques of surface science : Woodruff and Delchar
2. Solid State Physics : Ashcroft and Mermin
3. Amorphous Materials : S.R.Elliot
4. Fundamentals of surfaces and thin film analysis : L.C.Feldman and J.W.Mayer
5. An introduction of X-ray crystallography : M.M.Wofson
6. Use of films in Physical investigations : J. C. Anderson
7. Rutherford backscattering Spectroscopy : W. K. Chu

Semester III

Choice Based Elective

Photonics

PHM-32E

Unit I: Polarization Optics

Polarization of Light, Optics of anisotropic media: The index ellipsoid, Birefringence, Polarization devices: Wave retarders, rotators and optical isolators. Magneto-Optic effect: Optical activity and Faraday effect

Unit II: Electro-optics and Acousto-optics

Pockels and Kerr Effect- Electro-optics of Anisotropic media, Phase and amplitude modulators, Beam Deflection and scanning devices, Photorefractive materials. Acousto-optics, Bragg diffraction and acousto-optic devices and their applications.

Unit III: Non-linear Optics and Optical Bistability

Non-linear optical media, second order non-linear optics- SHG, Three wave mixing. Third order non-linear optics, THG and self phase modulation. Four wave mixing and Optical Phase conjugation. Frequency conversion, Parametric Amplification and Oscillation. Self focusing of light. Bistable Systems, Principle of optical bistability, Bistable Optical devices, Optical logic and switching.

Unit IV: Photonic-Crystal Optics

Optics of Dielectric Layered Media: Matrix theory of multilayer optics, Bragg Grating. One-dimensional photonic Crystals - Bloch modes, dispersion relation and photonic band structure. Two- and three dimensional photonic crystals.

Reference Books:

1. Fundamentals of Photonics: B.E.A. Saleh and M.C. Teich
2. Photonics: Ralf Menzel
3. Quantum Electronics : A.Yariv
4. Nonlinear Optics : R.W. Boyd
5. Optics and Lasers : M.Young
6. Optical Electronics : A. Ghatak & K. Thyagarajan

Semester III

Choice Based Elective

General Relativity

PHM-33E

Unit I: Geometrical Basis

Vector and tensor fields, Affine connections, Metric tensor, Covariant derivative, Parallel transport Geodesic equation, Riemann curvature tensor. Symmetry properties of Riemann tensor. Bianchi identity. Ricci and Einstein tensor.

Unit II: Physics in Curved Spacetime

Equivalence Principle, Gravity as spacetime curvature, Weak gravitational field limit, Stress-energy tensor for a perfect fluid. Conservation equation for matter, Einstein equations (From Action Principle), Weak field limit of Einstein equations.

Unit III: Gravity in Simple Situations

Einstein equation in vacuum, Schwarzschild solution, Motion along a geodesic, Newtonian approximation, Gravitational redshift, Planetary motion and precession of the perihelion. Bending of light by a gravitating body.

Unit IV: Black Holes

Singularities in the Schwarzschild metric, Schwarzschild solutions in Kruskal-Szekeres coordinates. Gravitational collapse and black formation, Spherically symmetric collapse of dust, Reissner Nordstrom solution, Kerr solution.

Unit V: Cosmology

Cosmological principle; Robertson-Walker metric; Hubble's Law, Cosmological Redshift, Deceleration parameter, Distances, Cosmological fluid and its components, Matter conservation equation, Friedman Equation and Standard models, Closed, Flat and Open universe, Age of the universe.

Reference Books:

1. General Relativity : M.P.Hobson, G.P. Efstathiou and A.N.Lasenby
2. Gravitation and Cosmology : S.Weinberg
3. The Classical Theory of Fields: L.D.Landau and E.M.Lifshitz
4. Gravity: J.B.Hartle
5. Spacetime, Geometry and Gravitation : Pankaj Sharan

Semester III

Skill Enhancement Course

Numerical Analysis And Programming

PHM-31A

Unit I: Lab sessions

Sources of errors, propagation of errors in arithmetic operations, representation of numbers on computers, arithmetic of normalized floating point numbers, computer algorithm, Implementation of Numerical techniques using Fortran 2003/ANSI C.

Unit II: Solution of algebraic and transcendental equations

Chebyshev method, Steffensen method, Fixed point iteration, order of convergence, Singular Value Decompositions(SVD), eigenvalues and eigenvectors, Givens method and Householder method for symmetric matrices, QR Decompositional linear sparse systems, power method for finding extreme eigenvalues and eigenvectors; Maximization and minimization of functions.

Unit III: Interpolation and extrapolation

Lagrange's interpolation polynomial, Hermite Interpolation, Cubic spline interpolation, Fast Fourier Transform, Least square approximation, Approximation using orthogonal polynomials, Maximization for minimization of functions.

Unit IV : Differentiation and Integration

Differentiation based on Lagrange's Interpolation polynomial, two-point and three point formulae, Simpson's method, Romberg integration, Random number generator, Monte Carlo Integration; Gauss Quadrature: Legendre, Chebyshev, Hermite, Laguerre.

Unit V : Ordinary and partial differential equations

Ordinary differential equations, initial value problem, boundary value problem, Partial differential equations: parabolic, elliptic, hyperbolic; Finite Element Method(FEM)

Reference Books:

1. Numerical Analysis: C. F. Gerald, P. O. Wheatley
2. Numerical Analysis for Scientists and Engineers Theory and C Programs : Madhumangal Pal.
3. Fortran 95/2003 for Scientists and Engineers : Stephen J Chapman
4. Numerical Methods for Scientific and Engineering Computation : Jain, Iyengar and Jain
5. Numerical Analysis: Richard L Burden and J Douglas Faires
6. Computational Physics : J M Thijssen .
7. Numerical Recipes in C : The Art of Scientific Computing : Press, Teukolsky, Velleling and Flannery

Semester III

Physics Practical

Lab III

PHM-31L

List of Experiments :

1. Study of characteristics of a single mode optical fiber and determination of transmission losses.
2. Study of characteristics of a multi mode optical fiber and determination of transmission losses.
3. Determination of the (i) Rydberg constant using an optical grating and Hg lamp; (ii) H₂ and He spectral wavelengths.
4. Study of diffraction of light from a laser light source through a single slit using a photo-cell.
5. Determination of the specific charge of the electron by the Millikan's oil drop method.
6. Study of the Zeeman effect in Hg light spectra.
7. Study of electron diffraction upon transmission through a thin graphite film.
8. Study of diffraction and interference in microwaves.
9. Study of the characteristics and efficiency of a PEM fuel cell system.
10. Determination of the Curie temperature of ferromagnetic materials.
11. Study of a Fabry-Perot interferometer.
12. Study of radioactivity by using a G.M. tube to : (i) determine the range of α , β particles in air and (ii) absorption of γ radiation in various materials.
13. Study of energy storage using a solar thermal training system.
14. Study of solar photovoltaic cells (i) singly and (ii) in series and parallel configurations.

Semester IV

Core Course

Statistical Mechanics

PHM-41C

Unit I: Statistical basis of thermodynamics

The macroscopic and the microscopic states, phase space, trajectories and density of states, Liouville's theorem, ensemble theory, the principle of maximum entropy, contact between statistical mechanics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox

Unit II: Canonical and grand-canonical ensembles

Classical canonical ensemble, partition function, calculation of statistical quantities, Energy fluctuations. The grand canonical ensemble, particle number fluctuation. Entropy in grand canonical ensemble, thermodynamic potentials.

Unit III : Quantum Statistical Mechanics

Postulates of quantum statistical mechanics, density matrix, statistics of ensembles. Statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi-Dirac and Bose Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

Unit IV: Phase transitions

Type of phase transitions, first and second order phase transitions. Ising model, mean-field theories of the Ising model in two and three dimensions, exact solution in one dimension. Connection of Ising model to lattice gas and binary alloy models. Landau theory of phase transition, Landau free energy for second and first order transitions, critical exponents and universality classes.

Reference Books:

1. Statistical and Thermal Physics : F. Reif
2. Statistical Mechanics : K. Huang
3. Statistical Mechanics : R. K. Pathria
4. Statistical Mechanics: R. Kubo
5. Statistical Physics : Landau and Lifshitz
6. Thermodynamics and Statistical Mechanics : Greiner, Neise and Stocker
7. Statistical Physics : F. Mandl

Semester IV

Core Course

Condensed Matter Physics II

PHM-42C

Unit I: Interacting Electrons in Solids

Review of free electron theory, nearly free electron approximation, tight-binding model, LCAO approximation, Wannier functions, Hartree-Fock approximation, Dielectric constant of metals and insulators.

Unit II: Optical Properties

Electronic, interband and intraband transitions, relation between optical properties and band structure, reflectance, diffraction, dispersion, photoluminescence, electroluminescence, optical constants, Kramers-kronig relations, polarons, excitons, plasmons.

Unit III : Magnetism

Diamagnetism (including Landau diamagnetism) and Paramagnetism including van Vleck and Langevin paramagnetism), Exchange interaction of free electrons, Band model of Ferromagnetism, superexchange, double exchange, Hubbard model, Antiferromagnetism, Neel temperature, spin-waves, 2D electron gas in a magnetic field :Quantum Hall Effect. Landau levels. Degeneracy. Fractional quantum Hall effect.

Unit IV: Superconductivity and Superfluidity

Fundamental phenomena of superconductivity, Meissner effect, London equation, Type I and type II superconductors. Ginzburg-Landau Theory, Coopers pairing and BCS theory. BCS wave functions, Josephson Effect, SQUIDS. Weakly interacting Bose gas, Superfluidity.

Reference Books:

1. Introduction to Solid State Theory : O. Madelung
2. Solid State Physics : Ibach and Luth
3. Solid State Physics : Ashcroft and Mermin
4. Introduction to Solid State Physics : C. Kittel
5. Quantum Theory of Solid : C. Kittel
6. Many-Particle Physics (Physics of Solids and Liquids) : G.D. Mahan

Semester IV

Core Course

**Physics & Technology of
Semiconductor Devices**

PHM-43CM

Unit I: MESFET and Related Devices

Metal-semiconductor contacts; Basic Characteristics, Schottky Barrier, Ohmic Metal Semiconductor Contact, Current Transport process, Determination of Barrier Height, MESFET; Device Structures, Principles of Operations, Current Voltage Characteristics, High Frequency Performance, MODFET or HEMT; fundamentals, , Current -Voltage Characteristics, Cut off Frequency.

Unit II: MOSFET and Related Devices

MOS Diode; SiO₂-Si MOS Diode, Charge Coupled Device (CCD), MOSFET Fundamentals; Basic Characteristics, Types of MOSFET, Threshold Voltage Control, MOSFET Scaling; CMOS and BiCMOS; MOS Memory Structures.

Unit III: Quantum Effect and Photonic Devices

Quantum-Effect Devices; Resonant Tunneling Diode, Unipolar Resonant Tunnelling Transistor, Semiconductor Laser; Semiconductor Materials, population Inversion at a junction, Emission spectra for p-n junction Lasers, Basic Laser Structure, Photodetector; Photoconductor, Solar Cell; p-n junction Solar cell, conversion Efficiency.

Unit IV: Film Formation and Epitaxial Growth

Thermal Oxidation; Dielectric Deposition; Thin Films Deposition Techniques: Thermal evaporation, Sputtering, Chemical Vapour Deposition(CVD), LPCVD, Epitaxial Growth Techniques: Vapour phase Epitaxy, Molecular Beam Epitaxy (Elementary description).

Unit V: Lithography, Etching and Diffusion of impurities

Optical Lithography; Exposure Tools, Masks, Photoresist, Electron Beam Lithography (Elementary description) ,Wet Chemical Etching, Dry Etching, Reactive Plasma Etching techniques and Equipment, Basic Diffusion Process: Diffusion Equations, Doping of Semiconductor.

Reference Books:

1. Semiconductor Devices Physics and Technology : S.M. Sze
2. Introduction to Semiconductor Devices: S.M. Tyagi
3. Physics of Semiconductor Devices : S.M. Sze,
4. Solid State Electronics : Ben G. Streetman
5. Material Science by Engineers : James F. Shackelford
6. The Physics of Semiconductor Devices : D.A. Eraser, Oxford Physics Series (1986)
7. Thin Film Phenomena : K.L. Chopra.
8. Semiconductor Physics and Devices : S.S.Islam

Semester IV

Core Course

Quantum Optics

PHM-43CL

Unit I: Quantum Theory of Radiation

Quantization of free electromagnetic fields, Fock states, Lamb shift, quantum beats, concept of photons, coherent and squeezed states of lights, quantum distribution theory and partially coherent radiation.

Unit II: Coherence and Light-matter interaction

First and second-order coherence, HBT effect, photon bunching and anti bunching, Poissonian and sub-poissonian light, photon counting and photon statistics, Atom- field interaction : semi classical theory and quantum theory, coherent trapping, electromagnetically induced transparency and lasing without inversion.

Unit III: Quantum theory of damping

Density operator method and Langevin approach, quantum theory of laser, squeezing of light in nonlinear optical process, Atom optics : mechanical effects of light, atomic interferometry, quantum noise in an atomic interferometer, limits to laser cooling.

Unit IV: Measurements in Correlated Quantum Systems

Introductory ideas on EPR paradox, Bells inequality, QND measurements and two photon interferometry

Reference Books:

1. Elements of Quantum Optics : Meystre and Sargent
2. Quantum optics : M.O. Scully and M.S. Zubairy
3. Optical coherence and quantum optics : Mandel and Wolf
4. Laser physics : Sargent, Scully and Lambs

Semester IV

Core Course

Particle Physics

PHM-43CT

Unit I: Invariance Principles and Symmetries

Charge conjugation, time reversal and parity, CPT theorem, Quark model and color and flavour quantum numbers, Weak isospin and hypercharge.

Unit II: Introduction to Gauge Theories

Abelian and non-abelian gauge theories, Spontaneous symmetry breaking, Goldstone theorem, Higgs phenomenon

Unit III: Standard Model

Historical introduction to Fermi theory and current algebra, Weinberg-Salam model, Basic Lagrangian, neutral current, GIM mechanism, KM matrix and CP violation.

Unit IV: Strong Interactions

Basic Lagrangian of QCD and its symmetries, Asymptotic freedom, Deep inelastic scattering

Unit V: Some Special topics

Anamolies, supersymmetry, string theory.

Reference Books:

1. Introduction to High Energy Physics : Perkins
2. Gauge Theory of Weak Interactions : Greiner & Muller
3. Gauge Theory and Particle Physics : Cheng Lee

Semester IV

Choice Based Elective

Physics of Novel Material

PHM-41E

Unit I: Quantum Well Structures

Electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of a quantum well structure, quantum dots, quantum wires

Unit II: Carbon nanotubes

Carbon nanotubes and other carbon materials, bonding between carbon atoms, single and multiwalled nanotube growth and characterization, electronic structure, crystal structure, junctions and defects of nanotubes. Electronic structure, transport, optical properties, thermal and mechanical properties of nanotubes. Electron spectroscopy and scanning probe microscopy of nanotubes. Applications of carbon nanotubes.

Unit III : Non-carbon nanostructures

Semiconductor heterostructures, synthesis of nanomaterials using chemical techniques.

Unit IV: MEMS & NEMS

MEMS (microelectromechanical systems) and NEMS (nanoelectromechanical systems), nanomachines and applications.

Reference Books:

1. Quantum Dot Heterostructures : D. Bimberg, M.Grundman, N.N. Ledentsov
2. Carbon Nanotubes: Synthesis, Structure, Properties and Applications : M.S. Dresselhaus, G. Dresselhaus, Ph.Avouris
3. Electronics in Non-crystalline materials : Mott and Davis
4. Physics of Amorphous materials : Elliot
5. Superconductivity : A. V. Narlikar
6. Introduction to Solid State Theory : O. Madelung

Semester IV

Choice Based Elective

Laser Spectroscopy

PHM-42E

Unit I: Laser Spectroscopic Instrumentation

Monochromators. Interferometers. Laser detectors: Photocells, Photomultipliers, Photon Counters, Optical multichannel analyzer, Boxcar averager. Laser powers/Energy meters.

Unit II: Doppler-limited Spectroscopy with Laser

Advantages of Lasers in spectroscopy. Doppler-limited absorption spectroscopy: Excitation spectroscopy, Optoacoustic spectroscopy, Intracavity absorption. Optogalvanic spectroscopy, Ionization spectroscopy. Laser induced fluorescence. Stepwise excitation. Spectroscopy of Rydberg states. Multiphoton spectroscopy.

Unit III: Nonlinear and Time resolved Spectroscopy

Doppler-free techniques in spectroscopy. Laser Raman spectroscopy: Stimulated Raman Scattering, Coherent Anti-stokes Raman spectroscopy(CARS), Experimental techniques of Laser Raman spectroscopy, Applications of Laser Raman spectroscopy, Non-linear Raman spectroscopy. Time resolved Laser spectroscopy: Lifetime measurements with lasers.

Unit IV: Recent trends in Laser spectroscopy

Spectroscopy of single ions, Spectral resolution within the natural linewidth. Absolute frequency measurements and Optical frequency standards.

Reference Books:

1. Laser Spectroscopy : W. Demtroeder
2. Atomic and Laser Spectroscopy : A. Corney
3. Molecular and Laser Spectroscopy : Zu-Geng Wang, Hui-Rong Xia

Semester IV

Choice Based Elective

Quantum Field Theory

PHM-43E

Unit I: Canonical Quantization

Canonical quantization of neutral scalar, Charged scalar, spin 1/2 and massive spin-1 fields, Fock space and observables. Field commutation, anti-commutation relations.

Unit II: Interacting Fields

Interaction picture. Normal product. Wick's theorem. Feynman propagator. S-matrix. Feynman rules and diagrams

Unit III: Quantum Electrodynamics

Quantization of electromagnetic field. Gupta- Bleuler condition. Indefinite metric. Feynman diagrams of QED.

Unit IV: Scattering (tree level) in QED

Tree level calculations of Moller, Bhabha, Compton and Scattering in external field

Unit V: Some Special topics

1-loop corrections and renormalization. RG equations.

Reference Books:

1. Introduction to Relative Quantum Field Theory : S.S. Schwebber
2. Introduction to Quantized Field Theory : Bogoliubov & Shirkov
3. Relativistic Quantum Mechanics : Bjorken & Drell
4. Quantum Field Theory : Bjorken & Drell
5. Quantum Field Theory : Itzyksen & Zuber

Semester IV

Core Course

Project

PHM-44C

Guidelines for Project in M.Sc. Course :

1. Projects would be allotted to III Semester students which have to be carried out and completed in Semester IV.

2. The students will have an option to select the project in their field of interest. The projects shall be undertaken under the supervision of faculty within the department of physics or any other department / center of the university. In case the student wishes to work with a scientist in an institute outside Jamia Millia Islamia, she/he shall need to have a co-supervisor within the dept. of physics, Jamia Millia Islamia.

3. The project will comprise of the following:

- Survey and study of background literature material
- Experimental/analytical/computational research work, Collection of data, analysis of results.
- A dissertation or project report to be submitted by the end of the 4th semester.

4. The final evaluation of the completed project work will be based upon the work done, the submitted project report and an oral presentation.

B. Sc. Instrumentation Course Detail

Semester-wise : 2012 onward

S. No.	Paper Code	B.Sc. (Instrumentation) Paper Name	Periods per Week	Credit
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Semester - I

1.	INST--1T1	Instrument Mechanisms	4	4
2.	INST--1T2	Electronics	4	4
3.	INST--1P1	Electronics & Computer Lab. I	4	2

Semester - II

1.	INST--2T1	Digital Electronics	4	4
2.	INST--2T2	Metrology	4	4
3.	INST--2P1	Mechanical Instrumentation Lab.	4	2

Semester - III

1.	INST--3T1	Optical Instrumentation	4	4
2.	INST--3T2	Vacuum Measurement Techniques	4	4
3.	INST--3P1	Optics & Vacuum Instrumentation Lab.	4	2

Semester - IV

1.	INST--4T1	Signal Conditioning, Operational Amplifiers & Applications	4	4
2.	INST--4T2	Microprocessors	4	4
3.	INST--4P1	Microprocessors & Computer Lab. II	4	2

Semester - V

1.	INST--5T1	Transducers	4	4
2.	INST--5T2	Instrumentation Systems	4	4
3.	INST--5P1	Transducers Lab.	4	2

Semester - VI

1.	INST--6T1	Industrial Instrumentation	4	4
2.	INST--6T2	Entrepreneurship	4	4
3.	INST--6P1	Project Work	4	2

B.Sc. INSTRUMENTATION SYLLABUS

Semester-wise : 2012 onward

Semester - I

INST-ITI INSTRUMENTATION MECHANISM

Unit 1. Introduction : Material for instruments, bearings, machine, bearings vs instrument bearings. Different type of bearings and guides. Locks and stops Locks, unidirectional locks, stops for linear motion, switching motion, switching stops, stops for rotary motion.

Unit 2. Couplings : Rigid couplings, couplings for shafts with longitudinal shift coupling for shafts with off-set of centers, coupling for shafts overrunning clutches single revolution clutches with permanent magnets. Energy storing elements : Mass Springs, leaf Springs, spiral springs, torsion springs, conical disc, springs

Unit 3. Joining : Adhesive and cemented joints, joints by elastic deformation, joints by wedge effect, screw joints, press fitted joints, joints by plastic deformation, beaded joints, folded joints, lapped joints, crimped joints, embossed joints, spreaded joints, joints by embedding.

Unit 4. Functional Mechanism : Gear Mechanism, friction wheel mechanisms, wedge and screw mechanisms, Linkage mechanisms, integrating mechanisms, differential quantity integrator, rate quantity integrator. Elements in high speed mechanisms Inertia, friction and energy.

Unit 5. Elements of workshop Technology : Covering fundamentals of simple manufacturing process machine tools like lathes drilling machine milling machines shaping machines metal framing and casting.

Books :

1. Elements of Precise Engineering by R. Roman
2. The Design and Use Of Instruments and Accurate Mechanism by White

INST-IT2 BASIC ELECTRONICS AND INSTRUMENTATION

Unit 1. A.C Fundamentals : (Frequency, Period, Phase concepts), Average and Effective Values, Fm Factor, Phasor Representation, Vector addition/ Subtraction, Polar Notation, Complex Notation. *Resisters :* General Information: Symbol, color code, Types such as Carbon, Metal Film, thin film, Thick film, wire wound, variable Potentiometers, Logarithmic, Linear multi-turn. *Their Physical Properties :* Temperature Dependence (Thermistor), Light Dependent (LDR), voltage dependent (VDR). Technical specification: wattage, working voltage. *Methods of Measurements:* very low and very High Resistance, Wheatstone Bridge, Its merit. *Inductors :* General Information: Symbol, type (air core, iron core, Ferrite core) choke, frequency response, methods of measurements. *Capacitors :* General Information: symbol, color code, types (air, paper, electrolytic, mica, tantalum, polystyrene) Fixed and Variable Capacitors. *Specification:* Power Factor, working voltage, measurement of capacitance.

Unit 2. Circuit theory : Resistors in series and parallel, Star-Delta Transformation, Kirchoffs current and voltage law. simple exercises, *Networks Theorem* : Superposition, Maximum Power Transfer, Thevenins Theorem, Norton's theorem, source Information, Millman's Theorem (simple Exercise), Two Port Network.

Unit 3. A.C Circuits : Resistance-Inductance-Energy Stored in capacitance-series circuits, RL, RC and RLC circuit. Power Triangle, Series Parallel circuits, Admittance (Exercise).
Resonance In A.C Circuits : Series Resistance, Frequency variation, Selectivity, Q Factor, Half Power Frequency- Band Width- Parallel Resistance- Two Branch Parallel Circuits- Resistance Variation – Resistance at all frequencies, Tunnel circuit.

Unit 4. Diodes, BJT and FET : Linear diodes, Zener Diodes, Varactor Diodes, Photo Diodes, Light Emitting Diodes, Optical Isolator, *Power Supplies* : Transformer, ratings, specifications, $V1/V2= I2/I1= N1/N2$. Efficiency and Losses. Rectifiers (Full wave, Half Wave Filters) Regulation (Line & Regulation). Zener diode as Voltage Regulator, Three pin Regulators and black box. Ideal constant Voltage source, Ideal constant current source concept. Construction and working of BJT and FET, BJT transistor amplifier circuit biasing in CB, CC and CE configuration, FET amplifier circuit, frequency response of 1 and 2 stage BJT amplifier circuit.

Unit 5. Cathode Ray Oscilloscope : General constructional details of C.R.O. Classification of C.R.O. C.R.T with Reference to the controls provided on the C.R.O panel, time base generators, synchronization and sweep circuits, Dual Trace C.R.O, Application of C.R.O.

Books :

1. Basic Electronics by Bernard Grob
2. Basic Electronics By Malvino
3. Electrical Measurement by Golding

INST-1P1 ELECTRONICS AND COMPUTER LAB (I)

Electronics:

To design a variable potentiometer, determination of internal resistance of a battery, use of SPDT and DPDT switches with LED, To study the temperature dependence characteristics of thermistors, To study the LDR and LED characteristics, I-V characteristics of P-N and Zener Diodes, Half wave and full wave rectifiers with filter circuits(ripple factors), Three PIN (IC) regulator, To find the operating point of NPN and PNP transistors (DC Load Line analysis) Characteristics of JFET, Impedance of LCR circuit.

Computer:

DOS, Windows, MS office (MS word, MS excel, Power point), Programming in Fortran and C languages (tutorials)

Semester - II

INST-2T1 DIGITAL ELECTRONICS

Unit 1. Number Systems : Introduction to decimal, binary, octal hexadecimal number system, BCD codes, Introversion of binary decimal, BCD, Octal, Hex. Parity Excess 3 Gray and Johnson

code, simple binary Arithmetic, Introduction to Excess 3 Arithmetic.

Unit 2. Logic Gate : Positive and negative Logic. Different Logic Gates such as AND, OR, NOT, NOR, NAND, EXOR, EXNOR, symbols and truth table. Introduction to different Logic Families (ERTL, DTL, TTL, ECL, CMOS) merits and demerits. *Case study of TTL NAND Gates :* Multimeter Input Transistor phase Splitter, Totem pole and open collector output concepts. Basic concepts of Fan In and Fan Out sinking and sourcing of Current.

Unit 3. Boolean Algebra and Combinational Logic : Boolean Axioms, D Morgans Theorem: Statement verification and application Simple combinational logic implementations. C-Mappings up to four variable (SOP and POS). Ones compliment half adder full adder interpretation of full adder as subtractor. Universal gates (NOR and NAND) its importance. Prove that any logic gate can be implemented by use of universal gates only, Introduction MEP (Map Entered Variables).

Unit 4. Sequential Logic : Differential Flip Flops such as RS, clocked RS, JK (Race condition). Master Slave J.K. D type and T Type Flip Flops. Explain D type as a delay element. *Shift Registers* Type of Shift Registers SI SO SI PO PISO shift right and shift left. Applications; Ring counter and Johnson's counter (Twisted Ring) multiple cycle delay element.

Unit 5. Counters : Asynchronous counter and synchronous counters (UP and Down) Module N counter. Concepts of counters as frequency dividers. BCD counters. *Data Routing Elements :* Multiplexer, De-multiplexers, Decoders, Encoders, Tri-state, Buffer, Priority Encoder. Display and display Drivers.

Books :

1. Digital Electronics by Merlin And Leach
2. Digital Principle And Application Malvino and Leach
3. Digital Electronics by V.K.Jain
4. Digital System Principles And Applications by R.J. Tocci
5. Digital Computer Fundamentals by T.C. Bartee

INST-2T2 METROLOGY:

Unit 1. Measuring Systems And Precision Instruments : Measuring with rules. Mathematical Concepts. Limiting Mean, range, variance, standard deviation, normal distribution, confidence intervals, Principle of Sampling.

Unit 2. Standards Of Measurements : Standards of length end standards. Vernier calipers fixed Gauges inside depth and height gauges, Gauge block surface plate micrometers, Angular measurements. sine-bars angle gauges levels clinometers auto collimators taper gauges. Direct measuring tools and instruments. Optical projectors and microscopes. Horizontal vertical and cabinet profile Projectors. Tool makers and workshop microscopes. End standards end bars slip gauges.

Unit 3. Comparison Measurements : Compactors Pneumatic electric and electronic compactors. Limits Fits and Tolerances. Interchangeability types of fits geometric dimensioning tolerance.

Interferences. Surface Characteristics. Evaluation and symbology. Surface roughness measurements profilometers.

Unit 4. Alignment Testing : Machine tools alignment machine beds. Alignment of axis (Spindle axis and bed spindle axis and line of centers) axial slip calibrator of lead screw alignment of telescopes. Interferometers Ultrasonic Pulse Echo and Resonance Gauging optical alignment. Equipment and Methods.

Unit 5. Surface Texture Measurements and Gauging : Testing of screw threads. Pitch and angle error. External and Internal thread gauges. Testing of gears involute geometry runout pitch profile lead backlash tooth thickness, roundness measurements lobing of cylinders. Measurements of inspection and quality control. Automatic Dimensional Controls, manufacturing processes.

Books :

1. Engineering Metrology by R.K Jain

INST-2P1 MECHANICAL INSTRUMENTATION LAB

Instrumentation : Drawing, Conventional Representation of common elements of instruments. External and internal Threads, slotted head, square and flat, radial fins, splined shaft, chain wheel, (sprocket wheel) ratchet and pinion, bearing (ball and rollers), Knurling, helical springs, compression springs with square and circular sections, tension spring, torsion springs.

Gears : Spur/Helical Gears, screw gears, rack and pinion, bevel gear (assembly), worm and worm wheel. Geometric Drawing. Orthographic Projections, sections, pictorial drawings. Proportionate Sketch and Isometric views of following Instruments: Voltmeters, single phase energy meters, ammeters and wattmeters, pressure gauge and Tachometers. Draft and pressure measuring devices, flow meters, pyrometer, control valves and actuator. I.S.A for instrumentation flow plan. *Experiments in Metrology :* 8 experiments to familiarize the use of instruments and techniques for measurement double ended plug gauge, micrometer calibration, plain ring gauge, taper plug gauge, straight edge, plug gauge on a comparator, sine bar.

Mechanical Measurements : 6 experiments to familiarize the use of instruments and techniques for measurement of temperature, flow, pressure, torque, strain, vibration and noise.

Semester – III

INST-3T1 OPTICAL INSTRUMENTATION

Unit 1. Optical components and their characteristics : Plane Mirrors, Achromatic Prisms, Direct Vision Prisms, Right angle prisms, Roof Prisms, Erecting prism systems, cube corner prisms, beam splitter cubes, curved mirrors, lenses, ophthalmic lenses. *Optical Instruments ;* Compound Microscopes, Projection Microscope, Binoculars, Telescopes - Terrestrial and astronomic, profile projectors, theodolites. 5hrs.

Unit 2. Laser Instrumentation : Principle of laser construction of the laser, application in distance measurements, interferometry and Holography.

Unit 3. Testing Optical Components : Newtons Interferoscope, Fizeau Interferometer, Tyman Green Interferometer, Mach-Zehnder Interferometer. Multiple beam Interferometer, Fabry Perot Interferometer Polarization interferometer, shearing interferometer. Autocollimator's, Rochi grating test, Focault Knife edge test. Haitmann and other Screen tests. Distance Measuring Interferometers. Bull testing Comparators.

Unit 4. Fiber Optics : Principles of Optical Fibers. Materials for optical fibers, production for optical fibers, sources detectors , couplings Application of Fibre Optics- illuminator's, imaging bundle, endoscopy, communications , fiber optic sensors.

Unit 5. Optical Materials and fabrication techniques : Optical glassed and their characteristics, crystalline materials. Optical Machinery Grinding Polishing Drilling Trepanning Spherical Curve Generator, Optical Tools, abrasive and materials. Making Optical Instrumentation Flats, mirrors, parallel plates, mirrors ,lenses, prisms, polishing crystals.

Books :

1. Fundamentals of Optics by Jenkins and white, McGraw Hill
2. Optics and optical instruments by Johnson, Dover, N.Y
3. Optical Glass Working by Twyman Felger and Watts, London
4. Optical Shop Testing by Daniel Malacara, John Wiley and Sons N.Y.
5. Optics and Atomic Physics by Satyaprakash

INST-3T2 VACUUM MEASUREMENT TECHNIQUES

Unit 1. Introduction to Vacuums – Fundamentals

Gas flow mechanisms, conductance calculations, concept of throughput and pumping speed. Rotary, roots and oil free pumps. Diffusion and Sorption pumps. Turbomolecular, cyro and ion pumps.

Unit 2. Pressure Measurement : by hydrostatics, thermal conductivity and ionization gauges. Gauge calibration using spinning rotor, diaphragm and mcleod gauges. vacuum components- traps baffles, valves seals and feed through's.

Unit 3. Vacuum materials and fabrication techniques : Leak detection techniques, Mass Spectrometer and Residual gas analysis.

Unit 4. High vacuum system design : Thin film deposition techniques (Thermal evaporation and modification)

Unit 5. Vacuum Applications : Freeze Drying, Food Processing industry, lamp industry, vacuum metallurgy, vacuum impregnation.

Books :

1. Introduction to the theory and Practice of High Vacuum Technology by L.Ward and J.P. Bunn, Butterworths London
2. Vacuum Technology by A. Guthrie, John Wiley and Sons.
3. Vacuum Deposition of Thin Films, L. Holland, Chapman and Hall.
4. Modern Vacuum Practice, Nigel Harris, McGraw Hill

INST-3P1 OPTICS AND VACCUUM LAB*Optics Experiments*

Image formation using lenses and lens combinations, Testing the angles of prisms using a mechanical level protector and auto collimator's, Testing the radius of curvature of spherical components and tools using a ring spherometer., Testing concave mirrors using a Renchi Grating, Testing a concave Mirrors using the Focault Knife edge test., Abbe Refractometer, Measurement of Refractive Index., Interference Fringes Young's Double Slit Experiment and Fresnel's Bi prism, Testing the Flatness of Plates Using Newtons Interfero-scope., Experiments with Michelson Interferometer, Experiments with a Laser Power Beam Diameter and Divergence, Familiarization of Holograms.

Vacuum Experiment

Service of the Rotary Pump, Conductance and speed of the Rotary Pump at the vessel, Working of Bourdan Guage barometers U Tube Manometers and MacLeod Guage, Secondary Guages like Pirani Penning and callibration of Guages, High vacuum Pumps and Measurement of High Vacuum, Study of Flanges feedthroughs valves, Design of High vacuum System a case study, Vacuum evaporation and preparation of mirror, Vacuum Degassing of material and selection of material for vacuum system, Leak detection techniques.

Semester - IV**INST-4T1 SIGNAL CONDITIONING, OPERATIONAL AMPLIFIERS & APPLICATIONS**

Unit 1. Signal Generation and Processing : Sine wave Generation (Using OP-Amp also) and amplitude stability, linear frequency control and quadrature output. sawtooth wave (Linear) square wave (Schmitt trigger circuit), triangular wave generators, pulse, step and stair case generators. The 555 timer.

Unit 2. Signal Conditioner : Instrumentation amplifier, programmable amplifier, (OTA based) characteristic, linearization, D.C Emphasis on Phase sensitive detectors and their importance in extracting signals "Lock In amplifier " burried under noise. Precision Rectifiers 723, 7105, 7965, peak detectors, sample and hold Circuits, (aperture time , acquisition time etc) comparators and qualitative importance of Logarithmic amplifiers, isolation amplifier, Optical Isolator,

Reference voltage and current reference.

Unit 3. Operational Amplifiers : Op-amp parameters, ideal op-amp, open loop op-amp configuration differential amplifier, inverting amplifier, non inverting amplifier, equivalent circuit of an op-amp., Op-amp linear application-dc amplifier, ac amplifier, summing amplifier, scaling amplifier, averaging amplifier, precision rectifier, instrumentation amplifier, integrator, differentiator.

Unit 4. Active filters-low pass high pass,band reject,all pass filter, Wave form generators-square wave,triangular,saw tooth, voltage controlled oscillator

Unit 5. Comparators : Basic Comparator types, characteristics,applications,zero crossing detector, Schmidt trigger,voltage limiters

Books For Signal Conditioning :

1. Instrumentation Devices and Systems by Ranger , Mani and Sharma.
2. Electronic Measurements and Instrumentation by Olive and Cage.
3. Electronic Instrumentation and measuring techniques by Cooper.
4. Principle of Active Network Synthesis and Design by G. Daryanari, John Wiley and Sons
5. Filter Theory and Design by Sedra and Bracket, Active and Matrix Publisher

Books For Operational Amplifier :

1. Op-amps and linear integrated circuits by E.A. Gayakwad, Prentice Hall India.
2. Operational Amplifiers and Applications by Subirkumar Sarkar, S. Chand & Co.
3. Operational Amplifiers and Linear Integrated Circuits by Robert F. Coughlin and Frederick F. Driscoll, Prentice Hall India, New Delhi
4. Digital Principles and Applications by Malvino and Leach 4th Ed. TMH
5. Digital Fundamentals by Thomas L Floyd, Merril Publishing Co, US

INST-4T2 MICROPROCESSOR

Unit 1. Microprocessor Architecture : Memory organization: Type of memories (RAM, EPROM, ROM, PROM, DRAM), basic concepts of memory organization (Number of address line required arrangement of memory cells, control line memory extension), concepts of control lines such as Read/Write chip enable. Register to register transfer via data bus. Arithmetic and Logic Unit (ALU) , detail design of of a small 'ALU'. an ALU which performs four basic functions (ADD , SUBTTY, OR, AND), Need for decoder integration of ID with "ALU" to form an ALU with Control signals. Control and timing unit: Need for this ninth , concept of sequence of execution of and instruction, integration of all three (i,ii,iii) to form C.P.U.

Introduction to 8085 Architecture : Block Diagram, Address Bus, Control Bus, Data Bus, Need to multiplex address and data bus, Memory organization(with emphasis on demultiplexing address and data bus during memory read and memory write. Control and timing unit.. ALU details. Registers, Flags

Unit 2. Instruction Set : Introduction, classification of instruction set, opcode format some

basic instructions. (i) Data Transfer instructions, this must include (a) immediate addressing, Register addressing, Direct addressing, Indirect addressing, Arithmetic and Logic Instructions. ADD, Sub, AND ,OR, XOR, CMP.

Control and Timing : Sequence of execution of instruction. Concept of Instruction Cycle and Machine Cycle. Various types of machine cycle along with associated control and status signals (Op Code Fetch, memory Read ,Memory Write. I/O Read, I/O write, IO/M, SO, SI, MR, MW/Detail timing diagram of some instructions.

Unit 3. Advanced Instructions : Branching conditional and unconditional subroutines, concept of stack, need for stack pointer

Unit 4. Interfacing : Concept of Interrupts, classification of interrupts, various types of interrupts (5,5,6,5,7,5) TRAP, Hardware : Software Interrupts RST0, to RST7 instruction associated with interrupts (RIM, SIM, EI, D10 Typical examples illustrating usage.

Unit 5. Interfacing with peripherals : Concept of Input and Output ports of 8255, 8279, 8253 (General description, how to programme, usage). Interfacing of A/D and D/A Converters.

Books :

1. Microprocessor Architecture, Programme and Applications by Gaonkar.
2. Digital Computer Electronics by Albert Paul Malvino (TMH) 1st edition.
3. Microprocessors and Application by Mathur.

INST- 4P1 MICROPROCESSOR AND COMPUTER LAB-II

Microprocessors

Addition, Subtraction, Multiplication, Average, Delay generation, clock using delay, key board recognition routines, display of items,, interfacing of keyboard modules, interfacing of A/D and D/A converter, stepper motor control using microprocessor.

Computer

Exercise in DOS, Exercise in UNIX, C Programming in DOS, C Programming in UNIX, Assembly Language programming In DOS, Circuit Design and Simulation Using Electronic Work Bench, Microprocessor

Semester - V

INST-5T1 TRANSDUCERS

Unit 1. Philosophy of Measurement and Error Analysis : Units and Standards calibration Techniques Classification of errors – classification of errors- error analysis- Statistical Methods, MTBF, MTTR.

Unit 2. Static and Dynamic Characteristics : Accuracy, Repeatability, hysteresis, etc Characteristics of Transducers - Static Calibrations Mathematical Model of Transducers-0, 1st, 2nd order Transducers - Response to Ramp and Sinusoidal inputs.

Unit 3. Variable Resistance Transducers : Principle of operational details characteristic and applications of potentiometric - Hot wire anemometer - RTD - Thermistor -Humidity sensors.

Unit4. Variable Inductance and Variable Capacitance Transducers :Inductive Transducers - LVDT-E.I Pick Up - Capacitive Transducers of different types. Capacitor Microphone-Floating Cell.

Unit 5. Other Transducers : Piezo Electric Transducers - Hall Effect - Ionization Transducers -Magneto restrictive Fiber Optic Transducers- Eddy Currents-Semiconductor Transducers-Electro - Optic Transducers-IC Sensors - Shaft angle Encoder, Digital Transducer-Smart Transducers-Their salient features.

Books For Transducers :

1. Measurement System Application and Design by E.O. Doebelin, Mc Graw Hill Book Co, IV edition 1990.
2. Instrumentation Devices and Systems by C.S. Rangan, V.S.V. Mani and G.R. Sarma, Tata McGraw Hill.
3. Instrument Transducers by H.K.P. Neubert, Clarendon Press, Oxford.
4. Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai and Sons.
5. Transducers and Instrumentation by D.V.S. Murthy, Prentice Hall of India Pvt. Ltd.

INST-5T2 INSTRUMENTATION SYSTEM

Unit 1. Analytical Instrumentation : Introduction to instrumentation System need for an Integral approach. *Analytical Instruments* : Working Principles Operation and data analysis of the following instruments Spectro-photometers atomic AAS electron Microscope.

Unit 2. Nuclear Magnetic Resonance Spectrometer : Principle of Operation Sample Preparation and data analysis. Stability of magnetic Fields and electronics. *Mass Spectrometer* : Application areas working principles of static and dynamic instruments analysis of data, *Mossbauer Spectrometers* : Principles of operation measurement of Radioactivity analysis of data.

Unit 3. X-Ray : Techniques and Their application to Radiography Fluorescence and Diffractometry, interpretation of data.

Unit 4. Biomedical Instrumentation : Introduction to Transducers and their Application Recording Electrodes, EEG, ECG and Other Potentials : Working Principles and precautions Blood Pressure Measurements : Introduction to Hemodynamics, Introduction to Ultrasound and Topographic Techniques : Interpretation of Data and Precautions for measurements Introduction

to Working Principles and operation of Pacemakers : Defibrillators Heart lung and Other ICU Instrumentation.

Unit 5. Environmental Instrumentation :

General Introduction To Physical Environment : Physical aspects like Pressure temperature humidity noise visibility air quality and water quality, Humid atmosphere Hygrometers and dew point instruments controlled humidity environment. Thermal Comfort meter Heat Stress Monitor and temperature Monitors, Hot wire anemometer lidar ind velocity and effect on dispersion of pollutants. Cup anemometer, Sound level meters tape recorders noise dosimeters sound level monitors and acoustical calibrators, Solar Flux Pyranometers pyrhemometers, Water Quantity by Turgidity Meter calorimeter pH meter microscopes atomic absorption spectroscopy. Air Quality measurement using gas chromatography High pressure Liquid Chromatography gas Chromatography mass spectrometry conductivity meter, Particulate meter in air soiling index and visibility, Congenial environment for work, artificial lightings, acoustic consideration and air conditioning.

Books For Instrumentation System :

1. Air Pollution Physical and Chemical fundamentals by J.H.Seinfeld McGraw-Hill NY.
2. Meteorological Instruments by W.E Knowles Middleton and A.F Spilhans, University Toronto Press.
3. Instrumental Methods of Analysis 6th Ed. By H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle.
4. Environmental Instrumentation by L.J. Frichtschen, and L.W. Gay.

INST-5P1 TRANSDUCERS LAB

Practicals in Op-Amp., Inverting, Non -inverting, Buffer, Offset Balance, Sine Wave and Square wave Generators (Amplitude Stability), Filters: Low Pass, High Pass, Band Pass, All Pass Filters, Transducers : (Exp, Set Up), Strain Guage, LVDT, Load Cell, Thermistor or Diode as Temp.Sensor, Hall Effect Transducer.

Semester - VI

INST-6T1 INDUSTRIAL INSTRUMENTATION

Unit 1. General Techniques : Measurement of industrial parameters : Discussion of load cells, torque meter and various velocity pick-ups, Exposure to various accelerometer pick-ups, Vibrometers, density and viscosity pick-ups, Pressure Transducers, Temperature standards, calibration and signal conditioning used in RTD's, Thermocouples and Pyrometry techniques, *Miscellaneous Measurements* : Time Frequency, phase angle, vibration instruments, noise measurements, liquid level, humidity, chemical composition.

Measurement of force, torque and velocity : Electric balance – Different types of load cells – Magnets – Elastic load cells - Strain gauge load cell – Different methods of torque measurement – Strain gauge, relative regular twist – Speed measurement – Revolution counter – Capacitive tacho-drag cup type tacho – D.C and A.C tacho generators – Stroboscope.

Unit 2. *Measurement of acceleration, vibration, density, viscosity and Liquid Level* : Accelerometers – LVDT, piezoelectric, strain gauge and variable reluctance type accelerometers – Mechanical type vibration instruments – Seismic instrument as an accelerometer and vibrometer – Calibration of vibration pick-ups – Units of density, specific gravity and viscosity used in industries – Baume scale, API scale – Pressure head type densitometer – Float type densitometer – Ultrasonic densitometer – Bridge type gas densitometer – Viscosity terms – Saybolt viscometer – Rotameter type, liquid level measurements.

Unit 3. *Pressure Measurements* : Units of pressure - Manometers – Different types – Elastic type pressure gauges – Bourdon type bellows – Diaphragms – Electrical methods – Elastic elements with LVDT and strain gauges – Capacitive type pressure gauge – Piezo resistive pressure sensor – Resonator pressure sensor – Measurement of vacuum – McLeod gauge – Thermal conductivity gauges – Ionization gauge, cold cathode and hot cathode types – Testing and calibration of pressure gauges – Dead weight tester.

Unit 4. *Temperature Measurements* : Definitions and standards – Primary and secondary fixed points – Calibration of thermometer, different types of filled in system thermometer – Sources of errors in filled in systems and their compensation – Bimetallic thermometers – Electrical methods of temperature measurement – Signal conditioning of industrial RTDs and their characteristics – Three lead and four lead RTDs. Radiation method of temperature measurement, Total radiation and Selective radiation Pyrometer, Optical Pyrometer, Thermocouples, Laws of Thermocouple, Fabrication of industrial thermo-couples , Signal conditioning of thermocouples output.

Unit 5. *Flow Measurements* : Bernoulli Theorem, Pitot-static tube, Venturi-meter, Orifice Meter and Nozel Meter, Ultrasonic Flow Meter, Hot-wire Anemometer, Electromagnetic Flow Meter and Laser Doppler Anemometer.

Books :

1. Measurement Systems – Application and Design by E.O. Doebelin, Tata McGraw Hill Publishing Company
2. Mechanical and Industrial Measurements by R.K. Jain, Khanna Publishers, New Delhi
3. Principles of Industrial Instrumentation by D. Patranabis, Tata McGraw Hill Pub. Co.
4. A Course on Mechanical Measurements - Instrumentation and Control by A.K. Sawhney and P. Sawhney, Dhanpath Rai and Co.
5. Instrumentation Measurement & Analysis by B.C. Nakra & K.K. Chaudary, Tata McGraw Hill Co. Publishing Ltd.
6. Industrial Instrumentation and Control by S.K. Singh, Tata McGraw Hill, 2003
7. Industrial Instrumentation by D.P. Eckman, Wiley Eastern Ltd.,

INST-6T2 ENTREPRENEURSHIP

Unit 1. *Entrepreneur* : Type of Entrepreneurs, Qualities of a successful Entrepreneur, Functions of an entrepreneur, Entrepreneurship, barriers to entrepreneurship, environmental factors influencing entrepreneurship, Entrepreneurial motivation, industry and its classification.

Unit 2. Project Management : Meaning of a project , Project Identification Project Report, Network Planning techniques, Basic concept in network analysis, construction of network diagram. CPM 4 PERT , concept of project appraisal. Project appraisal methods. cash flow as cost and benefits play back period, Average rate of return. Discounted cash flow techniques. concept of factory design. type of factory buildings factory layout objectives and types.

Unit 3. Method of estimating cost, performa balance sheet and profit and loss account, project appraisal in public enterprise, public investment decision making in India. Privatization sources of finance cost of capital, project finance term loans, lease finance sources of short term finance financial institutions institutions assisting entrepreneurs.

Unit 4. Concept of marketing channel, selecting channel members, alternative channels of distribution Mercantile agents Merchant middle men Wholesalers Retailers Phases of Entrepreneurial development program, concepts of training programme for ED, Special agencies and schemes.

Unit 5. Steps to be taken for small industries, preparation of project report guidelines. Sole proprietorship partnership, joint stock company, factors effecting the choice of organization. meaning of incentives and subsidies. Needs and Problems Schemes of incentives in operation, Machinery on hire purchase Transport subsidy. Taxation benefits to SSL. Exports and Imports.

Books :

1. Developing Entrepreneurship- A Hand Book by T. Venkateswara Rao, Eureka Marketing Group
2. Entrepreneurship and Entrepreneurship Development and Planning in India by D.N. Mishra, Chugh Publications
3. Development Bank and New Entrepreneurship in India by P.N. Mishra, National Publishing House
4. Entrepreneurship in Small Scale Industries by M.C. Gupta, Anmol Publications
5. How to Start Your Own Small Scale Industry by G.D. Sharma, Vision Books

INST-6P1 PROJECT

The project work is to be undertaken in consultation with the concerned teachers.