

CURRICULUM

Two years M.Sc. PHYSICS COURSE

1st Year:

1st and 2nd Semesters courses are common for all the M.Sc. Physics students belonging to the several Electives:

1st SEMESTER:

K L Education Foundation							
M.Sc (Physics)							
Course Structure 2019-20							
S.No.	Course Code	Name of the Course	L	T	P/S	Hours	Credits
Semester -1							
1	19PH5101	Mathematical Physics	4	0	0	4	4
2	19PH5102	Classical Mechanics	4	0	0	4	4
3	19PH5103	Electrodynamics	4	0	0	4	4
4	19PH5104	Analog Electronics	4	0	0	4	4
5	19PH5105	Computational Physics	4	0	0	4	4
6	19PH5106	Analog Electronics Lab	0	0	6	6	3
7	19PH5107	Computational Physics Lab	0	0	4	4	2
8	19PH5108	Seminar-1	0	0	2	2	1
Total			20	0	12	32	26
Semester -2							
1	19PH5201	Statistical Mechanics	4	0	0	4	4
2	19PH5202	Quantum Mechanics - 1	4	0	0	4	4
3	19PH5203	Fiber Optics and Non-linear optics	4	0	0	4	4
4	19PH5204	Solid State Physics-1	4	0	0	4	4
5	19PH5205	Digital Electronics	4	0	0	4	4
6	19PH5206	Solid State Physics-1 Lab	0	0	6	6	3
7	19PH5207	Digital Electronics Lab	0	0	4	4	2
8	19PH5208	Seminar-2	0	0	2	2	1
Total			20	0	12	32	26
Semester -3							
1	19PH5301	Quantum Mechanics-2	4	0	0	4	4
2	19PH5302	Atomic and Molecular Spectroscopy	4	0	0	4	4
3	19PH5303	Nuclear Physics	2	0	0	2	2

4	19PH5304	Particle Physics	2	0	0	2	2
5	19PH5305	Solid State Physics -2	4	0	0	4	4
6	19PH5306	Lasers and Photonics	4	0	0	4	4
7	19PH5307	Term paper	0	0	4	4	2
8	19PH5308	Solid State Physics-2 Lab	0	0	6	6	3
Total			20	0	10	30	25
Semester -4							
1	19PH54EX	Elective-1	3	0	0	3	3
2	19PH54EX	Elective-2	3	0	0	3	3
3	19PH54EX	Elective-3	3	0	0	3	3
4	19PH5401	Dissertation	0	0	16	16	8
Total			9	0	16	25	17
Total Credits			69	0	50	119	94

ELECTIVE COURSES							
Elective-1							
1	19PH54E1	Experimental Techniques	3	0	0	3	3
2	19PH54E2	Basic Communication Theory	3	0	0	3	3
Elective-2							
1	19PH54E3	Physics of Nanomaterials	3	0	0	3	3
2	19PH54E4	Radar Systems and Satellite communication	3	0	0	3	3
Elective-3							
1	19PH54E5	Thin-film Technology	3	0	0	3	3
2	19PH54E6	Antenna theory and Radio wave Propagation	3	0	0	3	3

Semester-1 Courses Syllabus

Mathematical Physics (19PH5101)

Differential Equations:

Differential operators, common partial differential equations of physics; techniques for solving partial differential equations; general solution; homogeneous and non-homogeneous equations; Poisson's equations; spherical and cylindrical coordinates; plane and spherical waves; Laplacian in terms of angular momentum operator; second order linear ordinary differential equations; Greens' functions in one dimension; boundary conditions; Fuch's theorem, Legendre, associated Laguerre, Hermite, Bessel, and spherical Bessel equations; Hankel functions, gamma function; spherical harmonics; Schrodinger equation for H atom.

Variable and Separable:

Analytic functions, Cauchy-Riemann equations, integration in the Complex plane, Cauchy's theorem, Cauchy's integral formula. Liouville's theorem. Moretra's theorem. Proof of Taylor and Laurent expansions. Residue theorem. Integrals involving branch point singularity.

Group theory:

Groups, subgroups, Abelian groups, non-Abelian groups, cyclic groups, permutation groups, normal subgroups, Lagrange's Theorem for finite groups, group homomorphism's and basic concepts of quotient groups.

Linear vector spaces:

Scalar and vector fields, gradient, divergence, curl, line integrals, surface integrals, Green, Stokes and Gauss theorems. Linear operators. Matrix representation. The algebra of matrices. Special matrices. Rank of a matrix. Elementary transformations. Elementary matrices. Equivalent matrices. Solution of linear equations. Linear transformations. Eigenvalues and eigenvectors of matrices. The Cayley-Hamilton theorem. Diagonalisation of matrices. Principal axis transformation. Functions of matrices.

References Text book

1. Arfken, George "Mathematical Methods for Physicists" Second Edition, Academic Press, New York, 1970. This is a good book for review and reference. Vector analysis, coordinate systems, tensor analysis, determinants, matrices, infinite series, Green's functions.
2. Courant, R. and Hilbert, D. "Methods of Mathematical Physics", Vol. I. Interscience Publishers, Inc. N.Y., 1937. Has good treatment of n-dimensional vectors, orthogonal systems, norms, unitary transformations and eigenvalue problems.
3. G. Arfken (Academic Press) – Mathematical Methods for Physicists.
4. J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics.
5. P. Dennery and A. Krzywicki (Harper and Row) – Mathematics for Physicists.
6. W. Joshi (Wiley Esstern) – Matrices and Tensors
7. M. R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables.
8. G. Arfken (Academic Press) – Mathematical Methods for Physicists.
9. J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics.
10. P. Dennery and A. Krzywicki (Harper and Row) – Mathematics for Physicists.

Classical Mechanics (19PH5102)

Mechanics of Particles and Lagrangian Dynamics:

Newton's laws of motion - Mechanics of a particle - Equation of motion of a particle - Motion of a particle under constant force and alternating force - Mechanics of systems of particles- Angular momentum of the system - Potential and kinetic energies of the system - constraints and generalized coordinates- Lagrange's equations of motion and Application - Variational calculus and Least Action principle.

Central Force Problem and Rigid Body Motion:

Motion in a central force field - Motion of two particles equivalent to single particle - Equation of motion - Classification of orbits -Virial theorem-Kepler problem scattering in a central force field- Inelastic scattering in the laboratory frame - Motion of a rigid body - Orthogonal transformations - Euler angles- Coriolis effect - Angular momentum and kinetic energy – Rigid body dynamics and Moment of Inertia tensor - Euler's equation of motion – Torque Free Motion.

Hamiltonian Formulation:

Legendre transformations - Hamilton's equations of motion - Applications - cyclic coordinates and conservation theorems - Principle of least action - Canonical transformations – Poisson brackets – Properties of Poisson brackets – Constant of motion using Poisson brackets – Poisson brackets of canonical variables – Poisson's Theorem – Invariance of Poisson bracket under canonical transformation – Motion as successive canonical transformation (Infinitesimal generators) – Liouville's theorem

Hamilton Jacobi Theory and Oscillatory Motion:

Hamilton Jacobi equations for Hamilton's principal and characteristic functions – Harmonic oscillator problem – Separation of variables method – Action and angle variable– Linear harmonic oscillator application- Oscillatory Motion - Stable and unstable equilibrium – Theory of small oscillations –Eigenvalue problem - frequencies of free vibrations and normal modes – Lorenz transformation relativistic kinematics – Linear triatomic molecule - Two carts connected with three springs – Triple pendulum - Double pendulum.

Text Books:

1. H. Goldstein, *Classical Mechanics, 2nd Edition, Narosa, (1985).*
2. *Classical Mechanics by Gupta, S.L. Kumar and Sharma*

Ref. Books:

1. L. Landau and E. Lifshitz, *Mechanics, Oxford (1981).*
2. F. Scheck, *Mechanics, Springer (1994).*

Electrodynamics (19PH5103)

Electrostatics:

Laplace and Poisson's equations, Electrostatic potential and energy density of the electromagnetic field, Multipole expansion of the scalar potential of a charge distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an external field, Static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability, energy of charges in dielectric media (Maxwell stress tensor).

Magnetostatics:

The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term, Force and torque on a localized current distribution. (Magnetic stress tensor)

Boundary value problems:

Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems. Wave guide and its types, Introduction of TE, TM modes and their boundary values

Time varying fields and Maxwell equations:

Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.

Text Books:

1. Classical Electrodynamics: *S.P. Puri (Narosa Publishing House) 2011.*
2. Classical Electrodynamics: *J.D. Jackson, (New Age, New Delhi) 2009.*
3. Introduction to Electrodynamics: *D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2011.*

Reference Books:

1. Classical Electromagnetic Radiation: *J.B. Marion and M.A. Heald(Saunders College Publishing House) 2nd edition, 1995.*
2. Electromagnetic Fields, *Ronald K. Wangsness (John Wiley and Sons) 1st edition, 1986.*
3. Electromagnetic Field Theory Fundamentals: *Bhag Singh Guru and H.R. Hiziroglu*

Analog Electronics (19PH5104)

Circuit Theorems and Special Diodes:

Kirchoff's laws for current and voltage – Thevenin's and Norton's theorems and superposition theorems with examples – p-n junction diodes – Zener diode – tunnel diode – Schottky barrier diode – varactor diode-photodiode – solar cell – photodiodes and transistors – light emitting diode – semiconductor laser – UJT – opto-couplers.

Bipolar Transistor Amplifiers and FETs:

Biasing characteristics of junction transistors – analysis using re model-fixed bias-voltage divider bias-emitter bias – direct coupled transistor amplifiers – single stage transistor amplifier – frequency response – feed back in amplifiers – effect of negative feedback in amplifiers – FETs – different types-low and high frequency FETs, frequency response of FET – applications

Oscillators:

Low frequency and high frequency amplifiers – power amplifiers – oscillator principle – oscillator types – frequency stability response – phase shift oscillator – Wein bridge oscillator – LC tunable oscillators – multivibrators – monostable and astable – sine wave and triangle wave generation – clamping and clipping – crystal oscillators and their applications.

Operational Amplifiers:

Block diagram of a typical Op-Amp-DC and AC analysis of dual input and balanced output differential amplifier. Open loop configuration inverting and noninverting amplifiers. Op-amp with negative feedback- voltage series feedback – effect of feedback on closed loop gain input resistance, output resistance, bandwidth and output offset voltage- voltage follower.

Practical Op-amps:

Input offset voltage, input bias current, input offset current, total output offset voltage, CMRR frequency response. Summing amplifier, scaling and averaging amplifiers, integrator and differentiator, instrumentation amplifier. Oscillators principles, oscillator types, frequency stability, response, The phase shift oscillator, Wein bridge oscillator, Multivibrators-Monostable and astable, comparators – square wave and triangular wave generators.

Text Books:

1. R.L. Boylsted and L.Nashelsky, Electronic Device and Circuits, Pearson Education (2003).
2. J.Milman and C.C. Halkias, Electronic Devices and Circuits, McGraw-Hill (1981).
3. A.P. Malvino, Electronics:Principles and Applications, Tata McGraw-Hill (1991).
4. Op-Amps & Linear integrated circuits, RAMAKANTH A.GAYAKWAD (PHI), 2002, 4th Edition.

Computational Physics (19PH5105)

Fundamentals of C Language: C character set-Identifiers and Keywords-Constants-Variables-Data types-Declarations of variables –Declaration of storage class-Defining symbolic constants – Assignment statement. Operators - Increment and decrement operators –Conditional operators. Arithmetic expressions – Precedence of arithmetic operators –data input and output – The get char and put char functions-Scanf - Printf-simple programs. If-Else statements –Switch statement-The operator –GO TO –While, Do-While, FOR statements. **Python :** Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list;variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments.Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else).

MATLAB and Applications C character Basics of Mat lab- Mat lab windows – On-line help-Input-Output-File types-Platform Dependence-Creating and working with Arrays of Numbers – Creating, saving, plots printing Matrices and Vectors – Input – Indexing – matrix Manipulation-Creating Vectors Matrix and Array Operations Arithmetic operations-Relational operations – Logical Operations – Elementary math functions, Matrix functions – Character Strings Applications- Linear Algebra,-solving a linear system, Gaussian elimination, Finding Eigen values and eigenvectors, Matrix factorizations Curve Fitting and Interpolation – Polynomial curve fitting on the fly, Least squares curve fitting, General nonlinear fits, Interpolations.

Linear and Non –linear equations, Simultaneous equations: Solution of Algebra and transcendental equations-Bisection, Falsi position and Newton- Raphson methods-Basic principles-Formulae-algorithms. Solutions of simultaneous linear equations-Guass elimination and Gauss Seidel iterative methods-Basic principles- Formulae-Algorithms.

Interpolations, Numerical differentiation and integration: Concept of linear interpolation-Finite differences-Newton’s and Lagrange’s interpolation formulae-principles and Algorithms Numerical differentiation-algorithm for evaluation of first order derivatives using formulae based on Taylor’s series-Numerical integration-Trapezoidal and Simpson’s 1/3 rule-Formulae-Algorithms

TEXT BOOKS:

1. Programming in ANSI C by E.Balagurusamy, Tata McGraw Hill

2. Numerical Methods, E. Balaguruswamy, Tata McGraw Hill
3. Computer oriented numerical methods-Rajaraman.
4. Y.Kirani Singh and B.B.Chaudhuri, MATLAB Programming, Prentice-Hall India, 2007
5. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCE BOOKS:

1. Rudra Pratap, Getting Started with Matlab 7, Oxford, Indian University Edition, 2006
2. Stormy Attaway: A Practical introduction to programming and problem solving, Elsevier, 2012.
3. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

Analog Electronics Lab (19PH5106)

List of Experiments supposed to finish in Open Lab Sessions:

Lab session no	List of Experiments
1	Diode Characteristics.
2	Zener diode as voltage regulator.
3	Study of LED Characteristics.
4	Transistor Characteristics.
5	UJT Characteristics.
6	FET Characteristics.
7	Rectifiers by diodes and transistors
8	Active low pass, high pass and band pass filter using transistor
9	RC Phase Shift Oscillator using transistor.
10	Wein Bridge Oscillator.
11	Colpitt's Oscillator.
12	Astable Multivibrator using transistor.
13	Op-amp Characteristics.
14	Op-Amp as Summing amplifier, scaling and averaging amplifiers, integrator and differentiator, instrumentation amplifier
15	Astable Multivibrator using Op-Amp.
16	Low pass and High pass filters using Op-Amps.
17	Square wave and triangular wave generators.
18	Regulated power supply using IC723
19	Op-Amp as full wave rectifier.
20	Series and parallel resonant circuits.

Computational Physics Lab (19PH5107)

List of Experiments supposed to finish in Open Lab Sessions:

Lab session no	List of Experiments
1	Weekly Experiment/Exercise – I
2	Develop a program to print a message in C language
3	Write a program to take input and print t
4	Write a program to demonstrate switch and goto statements
5	Write a program to demonstrate Do-while and While-do statements
6	Write a program to demonstrate For statements
7	Write a program to enter and print some values in Python
8	Write a program to exchange the values of two variables in Python
9	Write a program to circulate the values of n variables in Python
10	Write a program to distance between two points in Python
11	Write a program to find eigen values in MATLAB
12	Write a program to perform curve fitting in MATLAB
13	To develop a MATLAB program for Algebra and transcendental equations.
14	To develop a MATLAB program of the Newton-Raphson method to find a root of a equation.
15	To solve the system of equations using Gauss elimination method by MATLAB program.
16	To solve the system of equations using Gauss-Seidel method by MATLAB program.
17	To develop a MATLAB program for bisection method to solve a function.
18	To develop a MATLAB program of the Falsi position method to find a root of a equation.
19	To develop a MATLAB program for general linear interpolation method.
20	To develop a MATLAB program of the Trapezoidal rule to evaluate the definite integral.
21	To develop a MATLAB program of the Simpson's rule to evaluate the definite integral.
22	To develop a MATLAB program of the Lagrange's formula to evaluate the missing data.
23	To develop a MATLAB program of the Newton's divided difference formula to evaluate the polynomial and missing data.
24	To write an Algorithms for numerical differentiation and develop a MATLAB program for numerical differentiation.

Seminar-1 (19PH5108)

Smester-2 Courses Syllabus Statistical Mechanics (19PH5201)

Thermodynamics

Equation of state for various thermodynamic systems - Laws of Thermodynamics - Consequences of equations of state and Thermodynamics laws - thermodynamics potentials - Maxwell's relations - Thermodynamic equilibrium conditions – Phase equilibrium - Gibbs' phase rule - phase transitions - Ehrenfest's classification - Microstates and macrostates – Ideal gas – Microstate and macrostate in classical systems.

Classical Statistical Mechanics

Postulates - Liouville's theorem microcanonical - canonical and grand canonical ensembles - Virial theorem and Equipartition of Energy theorem in these ensembles - equivalence of these ensembles - Expressions for entropy in terms of probability in these ensembles - Applications of these ensembles to classical ideal gas - N harmonic Oscillators - Langevin's theory of paramagnetism - problem solving.

Quantum Statistical Mechanics

Postulates of Quantum Statistical Mechanics – Density matrix - Applications to electron in a magnetic field - free particle - harmonic oscillator - and to multiparticle systems - Ideal Bose and Fermi gases in micro-canonical and Grand canonical ensembles – Bose-Einstein and Fermi-Dirac distributions - equations of state.

Ideal, Bose, Fermi gases and applications of statistical mechanics

Thermodynamic behavior - Expressions for equation of state - thermodynamic quantities in terms of Bose-Einstein & Fermi-Dirac functions and virial expansions - Bose-Einstein condensation - Fermi energy and Momentum - Black body radiation - Einstein & Debye theory for heat capacity (possibly Ising model)

Text Books:

1. Statistical Mechanics by Gupta & Kumar
2. Statistical Mechanics -- R K Pathria

Ref. Books:

1. An Introductory Course of Statistical Mechanics - Palash B.
2. Elements of Statistical Mechanics - Kamal Singh & S.P. Singh
3. Statistical Mechanics An Elementary Outline – Avijit Lahiri
4. Introduction to Statistical Physics - Kerson Huang

Quantum Mechanics-1 (19PH5202)

Introduction to Quantum Mechanics:

The Conceptual aspect: Wave particle duality, Bohr's complementarity principle. Wave function and its interpretation - Principle of superposition - Wave packets – phase velocity and group velocity - Uncertainty relation Postulates of Quantum Mechanics - Schrodinger wave equation - Conservation of probability.

Operators and Vector Spaces:

Operators and their properties - Equation of Motion for operators, Hermitian operators and their Eigen values and eigen functions Stationary states, Bohr's correspondence principle - Coordinate and Momentum representation - Ehrenfest's theorem Commutator Algebra.- Dirac Delta function, definition and properties. Dirac Delta Normalization.

One dimensional Problems:

One dimensional problems - Free Particle, Particle in a box - Potential step, potential Well, Rectangular Potential Barrier - Linear Harmonic Oscillator Angular Momentum, Angular Momentum in spherical

polar coordinates, Eigenvalues and eigenfunctions of L^2 , L_z , L_+ and L_- operators. Eigen values and eigen functions of Rigid rotator and Hydrogen atom. Commutation relations, electron spin.

Spin and Total angular momentum:

Spin angular momentum and Pauli spin matrices Total angular momentum J . Explicit matrices for J^2 , J_x , J_y & J_z . Combination of two angular moment and tensor operator: Clebsch-Gordon coefficients for $j_1=1/2$, $j_2=1/2$ and $j_1=1$, $j_2=1/2$ Wigner- Eckart theorem.

Text books:

1. Introduction to Quantum Mechanics - B. H. Bransden and C. J. Joachain
2. Quantum Mechanics - Gupta, Kumar and Sharma

Ref. Books:

1. Quantum Mechanics – L.I. Schiff.
2. Quantum Mechanics – A.P. Messiaha
3. Quantum Mechanics – E. Merzbacher
4. Quantum Mechanics – A.K. Ghatak and S. Lokanadhan and
5. A Text Book of Quantum Mechanics – P.M. Mathews and K. Venkatesan.

Fiber Optics and Non-linear Optics (19PH5203)

Introduction: Plane polarized wave – propagation of a light through a quarter wave plate – reflections at a plane interface – Brewster angle – total internal reflection – interference – refraction – concept of coherence – diffraction of Gaussian beam.

Fundamentals of Fiber Optics: Numerical aperture – attenuation in optical fibers – pulsed dispersion in step index optical fiber – loss mechanisms – absorptive loss – radiative loss – principle of optical waveguides – characteristics of fibers – pulsed dispersion in planar optical waveguide – modes in planar waveguides – TE, TM modes – propagation characteristics of step index and graded index optical fibers.

Intensity modulated Sensors: Transmission concept – reflective concept – microbending concept – intrinsic concepts – transmission and reflection with other optical effects - source of error and compensation schemes – phase modulation mechanisms in optical fibers – optical fiber interferometers – optical fiber phase sensors for mechanical variables – the optical fiber sagnac interferometer – optical fiber interferometric sensors.

Frequency modulation in Optical fiber sensors: Introduction – optical fiber Doppler system – development of the basic concepts. Polarization modulation in fiber sensors – introduction – optical activity – Faraday rotation – electro-gyration – electro-optic effect – kerr effect – photoelastic effect – polarization modulation sensors.

Text Boks:

1. D.A. Krohn, Fiber Optic Sensors: Fundamentals and Applications, 2nd edition, Instrument Society of America (1992).
2. B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
3. Djafar K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communications Technology, Pearson Education Asia (2001).

Solid State Physics-1 (19PH5204)

Crystal structure: Periodic array of atoms—Lattice translation vectors and lattices, symmetry operations, The Basis and the Crystal Structure, Primitive Lattice cell, Fundamental types of lattices—

Two Dimensional lattice types, three Dimensional lattice types, Index system for crystal planes, simple crystal structures-- sodium chloride, cesium chloride and diamond structures.

Crystal diffraction and reciprocal lattice: Bragg's law, Experimental diffraction methods- Laue method and powder method, Derivation of scattered wave amplitude, indexing pattern of cubic crystals (analytical methods). Geometrical Structure Factor, Determination of number of atoms in a cell and position of atoms. Reciprocal lattice, Brillouin Zone, Reciprocal lattice to bcc and fcc Lattices.

Lattice Energies and Lattice Vibrations: Origin of chemical binding in ionic and van der Waals crystals – Elastic properties – Stress and strain – Elastic moduli - Lattice energy calculations for ionic and van der Waals crystals – Lattice vibrations: Mono and diatomic one dimensional infinitely long lattices.

Free electron fermi gas: Energy levels and density of orbitals in one dimension, Free electron gas in 3 dimensions, Heat capacity of the electron gas, Experimental heat capacity of metals, Motion in Magnetic Fields- Hall effect, Ratio of thermal to electrical conductivity., Fermi surfaces of metals: Reduced zone scheme, Periodic Zone schemes, Construction of Fermi surfaces, Electron orbits, hole orbits and open orbits.

The band theory of solids: Nearly free electron model, Origin of the energy gap, The Bloch Theorem, Kronig-Penny Model, wave equation of electron in a periodic potential. The distinction between metals, insulators and semiconductors.

TEXT BOOKS:

1. Introduction to Solid State Physics, C.Kittel, 5th edition,
2. Solid State Physics, A.J.DEKKER.

Digital Electronics (19PH5205)

Logic Simplification and Combinational Logic Design: Number Systems, Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Karnaugh maps, Binary codes, Code Conversion, Integrated Circuit Logic Gates.

Combinational Logic Functions: Adder and Subtractor, Decoders, Encoders, Multiplexers, Demultiplexers, Magnitude Comparators, Parity Generators and Checkers, BCD to seven segment decoder, Verilog HDL design for Combinational Logic Functions.

Sequential Logic Functions: NAND/NOR Latches Gated Latches, Edge- Triggered Flip-flops. Registers and Counters: Shift register, Universal Shift Register, Design of Synchronous and Asynchronous Counters, Modulus counters. Mealy and Moore machines, State diagrams and Tables, FSM, Introduction to ASM charts. Verilog HDL design for Sequential Logic Functions.

Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Logic implementation using Programmable Devices. Complex Programmable Logic Devices, Field Programmable Gate Arrays, Applications of CPLDs and FPGAs.

TEXT BOOKS:

1. Stephen Brown and Zvonko Vrane "Fundamentals of Digital Logic with Verilog Design" Second Edition, McGraw-Hill.
2. M. Morris Mano, "Digital Logic and Computer Design", Pearson

REFERENCE BOOKS:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009
2. J. Bhasker, "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing.
3. Digital Fundamentals by A Anand Kumar, PHI

Solid State Physics-1 Lab (19PH5206)

Lab session no	List of Experiments
1	Lattice Constant measurement using X-ray diffracted film strip
2	Wavelength of LASER using diffraction grating
3	Hall magnetic fields
4	Internal resistance of a solar cell
5	Determination of Hall coefficient
6	e/m Thomson method
7	Characteristics of a Solar cell
8	Forbidden energy band gap
9	Thickness of wire using Wedge method
10	Series and parallel combination of solar cell
11	Resolving power of a prism
12	Planck's constant
13	Refractive index of various liquids using hollow prism
14	Refractive index of various liquids by forming Newton's rings
15	Diffraction grating for sodium doublet
16	Radius of curvature of lens by Newton's rings
17	Preparation of glass material using melt quenching method.
18	Determination of refractive index and energy band gap of glass material
19	Analysis of absorption spectra of amorphous materials (UV-vis-NIR)
20	Analysis of photoluminescence spectra of amorphous materials.

Digital Electronics Lab (19PH5207)

Lab session no	List of Experiments
1	LED Control Using Universal Gates
2	Combinational Circuit Based Car Security System
3	Participant selection in Competitions Using Multiplexer
4	Digital Display of Department Name
5	Random Number Generator for Gaming Using D-Flip-flop
6	Design of Automobile garage control system using counters
7	Digital Unlocking System using Shift Register
8	Digital Data Storage Using Semiconductor Memories

Seminar-2 (19PH5208)

Semester-3 courses syllabus

Quantum Mechanics-2 (19PH5301)

Perturbation Theory:

Time- independent perturbation theory for (i) non degenerate systems and application to Hydrogen atom: Kinetic energy correction, spin-orbit interaction, fine structure. Ground state of Helium atom. ii) degenerate systems, application to linear Stark effect in Hydrogen. Variation method and its application to Helium atom. Exchange energy and low lying excited states of Helium atom. Interaction of electromagnetic radiation with matter. Selection rules.

Time dependent perturbation:

General perturbations, variation of constants, transition into closely spaced levels –Fermi's Golden rule. Einstein transition probabilities, Interaction of an atom with the electromagnetic radiation. Sudden and adiabatic approximation.

Quantum Dynamics and identical particles

Equation of motion in Schrödinger's picture and Heisenberg's picture, correspondence between the two. Correspondence with classical mechanics. Application of Heisenberg's picture to Harmonic oscillator. The indistinguishability of identical particles – The state vector space for a system of identical particles – Creation and annihilation operators- continuous one particle system- Dynamical variables – the Quantum dynamics of identical particle systems

Scattering Theory and Relativistic Quantum Mechanics:

Differential and total scattering cross sections - laboratory and center of Mass Reference frames, Scattering amplitude, scattering by spherically symmetric potentials – partial wave analysis – Phase shifts. Klein-Gordon equation – its success and limitations – Dirac equation for a free particle - α and β matrices central forces and hydrogen atom.

Prescribed Text Books:

1. *Introduction to Quantum Mechanics* by B.H. Bransden & C.J. Joachain.
2. *A text book of Quantum Mechanics* – P.M. Mathews & K. Venkatesan.
3. *Quantum Mechanics* – L.I.Schiff 3rd Edition
4. *Quantum Mechanics* – Gupta, Kumar & Sharma

Reference Books:

1. *Quantum Mechanics* – Merzbacher
2. *Quantum Mechanics* – S.L. Kakani & H.M. Chandalia

Atomic and Molecular Spectroscopy (19PH5302)

Atomic Spectra

Quantum states of electron in atoms – hydrogen atom spectrum – electron spin – Stern Gerlach experiment – spin orbit interaction – Lande interval rule – two electron systems – LS-JJ coupling schemes – fine structure – spectroscopic terms and selection rules – hyperfine structure – exchange symmetry of wave function – Pauli's exclusion principle – periodic table – alkali type spectra – equivalent electrons. Zeeman and Paschen Back effect of one and two electron systems – selection rules – Stark effect.

Microwave Spectroscopy and IR Spectroscopy

Rotational spectra of diatomic molecules – rigid rotator – effect of isotopic substitution – non rigid rotator – rotation spectra of polyatomic molecules – linear, symmetric top and asymmetric top molecules

– experimental techniques – diatomic vibrating rotator – linear, symmetric top molecule – analysis by infrared techniques – characteristic and group frequencies.

Raman Spectroscopy

Raman effect – quantum theory of Raman effect – rotational Raman spectra – vibrational Raman spectra – Raman spectra of polyatomic molecules – Raman spectrometer – hyper-Raman effect – experimental techniques.

Electronic Spectroscopy and Resonance Spectroscopy

Electronic spectra of diatomic molecules – Frank-Condon principle – dissociation energy and dissociation products – rotational fine structure of electronic vibration transitions – Fortrat Diagram – predissociation. Inner shell vacancy – X-ray – Auger transitions – Compton Effect – NMR – basic principles – classical and quantum mechanical description – spin-spin and spin lattice relaxation times – magnetic dipole coupling – chemical shift – Knight shift – ESR – basic principles – nuclear interaction and hyperfine structure – g-factor – Zero field splitting.

Text Books:

1. *C.N. Banwell, Fundamentals of Molecular Spectroscopy, 4th edition, McGraw-Hill, New York (2004).*
2. *Arthur Beiser, Concepts of Modern Physics, 6th edition, Tata McGraw-Hill, New Delhi (2003).*
3. *G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall of India, New Delhi (2002).*
4. *B.P. Straughan & S. Walker, Spectroscopy: Vol. I, Chapman and Hall (1976).*
5. *Manas Chandra, Atomic Structure and Chemical Bond, Tata McGraw-Hill, New Delhi (2003).*
6. *G.M. Barrow, Introduction to Molecular Spectroscopy, Mc Graw Hill Ltd., Singapore (1986).*

Nuclear Physics (19PH5303)

Two body problem and Nuclear Forces

The Deuteron – Ground state of deuteron – Magnetic dipole moment of deuteron – Properties of nuclear forces – Scattering cross section – High energy nucleon-nucleon scattering – Spin dependence – Charge symmetry – Charge independence – Repulsion at short distances – Meson theory of nuclear forces – Exchange forces.

Nuclear Models

The degenerate gas model – Liquid drop model – Binding energy of nucleus – semi empirical mass formula (Bethe- Weizsacker formula) – Stability of nuclei against beta decay – Mass parabola – Fermi gas model – Alpha particle model – Shell model – Collective model – Optical model.

Radioactive Decays (Alpha, Beta, Gamma radiations):

Law of radioactive decay – Half life, mean life and successive radioactive transformation – Alpha decay and barrier penetration – Gamow's theory of alpha decay – Pauli's hypothesis and Fermi theory of beta decay – selection rules – Electron captures – Absorption of Gamma rays by matter – Interaction of Gamma ray with matter – Internal conversion.

Nuclear Reaction, Fission and Fusion

I: Types of reaction and conservation laws – Energetic of nuclear reactions – Isospin – Reaction cross section – Compound nucleus reactions – Breit -Wigner one level formula. **II:** Characteristics of fissions – Energy in fission – Fission reactors – Basic fusion processes – Characteristics of fusion – Solar fusion – Controlled fusion reactors.

Prescribed Text Books:

1. Introductory Nuclear Physics - Kenneth S Krane.
2. Nuclear Radiation Detectors - S.S. Kapoor & V.S. Ramamurthy
3. Radiation Detection and Measurement - G.F. Knoll

Reference Books:

1. The Atomic Nucleus - R.D. Evans.
2. Nuclear and Particle Physics - E.B.Paul.
3. Techniques for Nuclear and Particle Physics experiments - William. R. Leo

Particle Physics (19PH5304)

Particle Physics: Broad classification of elementary particles and particle interactions in nature, Properties of the Elementary Particles, Properties of the Fundamental Interactions conservation laws, symmetry classifications of elementary particles- Gell-Mann-Nishijima scheme, CPT conservation, Quark hypothesis & Quantum chromodynamics, Quark model and quark composition of mesons and baryons – Color and Flavor – Weak and Strong interactions – Standard model, Particle accelerators and detectors: linear accelerators, cyclotron, synchrotron, colliding beam accelerators (LHC), gas-filled counters, scintillation detectors, semiconductor detectors.

Text Books:

1. The Atomic Nucleus - R.D. Evans.
2. Nuclear and Particle Physics - E.B.Paul.
3. Techniques for Nuclear and Particle Physics experiments - William. R. Leo

Solid State Physics-2 (19PH5305)

Semiconductor Physics: Intrinsic and extrinsic semiconductors – Expression for position of Fermi levels and carrier concentrations – Variation of Fermi level with temperature – np product – Carrier mobility, conductivity and their variation with temperature – Direct and indirect band gap semiconductors – Differences and examples – Hall effect - Continuity equation – Drift and Diffusion – Einstein relation – Generation, Recombination and life time of non-equilibrium carriers – Heynes-Schockley experiment – Determination of life time, diffusion length of minority charge carriers.

Superconductivity: Concept of zero resistance – Magnetic behavior – Distinction between a perfect conductor and superconductor – Meissner effect – Isotope effect – Type-I, Vortex state of a Type II superconductors, difference between normal and superconducting states – London's equations – Penetration depth – BCS theory – Josephson junctions – SQUIDS and its applications - Applications of superconductors – High TC superconductors – Preparation – Properties.

Magnetic Materials: Types- Dia, para, ferro, anti-ferro & Ferri magnetic materials-Hysteresis curve-susceptibility measurement: Guoy balance, Quincke's Method- Quantum theories of para and ferro magnetism – Curie point and exchange integral – Curie temperature and Neel Temperature (Definitions) - Magnons – Domain Theory - Applications of Magnetic materials.

Dielectrics: Dielectric constant, types of polarization, local field, Clausius-Mossotti equation, frequency dependence of polarizations, piezo and ferro-electric materials and their applications.

Text Books

1. Solid State Physics, C. Kittel, John Wiley & Sons.

2. Solid State Physics, A.J. Dekkar, Macmillan India Ltd.
3. Elementary Solid State Physics, M. Ali Omar, Addison-Wesley.
4. Solid State Physics, M.A. Wahab, Narosa Publishing House.
5. Solid State Electronic Devices, B.G. Streetman.
6. High TC Superconductivity, C.N.R. Rao and S.V. Subramanyam.
7. Solid State Physics, S.O. Pillai.
8. Solid State Physics, S.L. Kakani and C. Hemarajan.
9. Electrons in Solids, Richard H. Bube.

Lasers and Photonics (19PH5306)

Energy distributions and laser design:

Boltzmann distribution, Population inversion, Rate equations, Stability conditions, Three level and four level lasers; Issues in designing a laser; Pumping mechanisms; Stable and unstable resonators, Laser Cavity, Longitudinal and Transverse Modes, Mode Selection, Gain in a Regenerative Laser Cavity; Q-switching, Mode locking, Laser amplification, Frequency conversion, Pulse expansion, Pulse shortening – Pico-second and Femtosecond operations, Spectral narrowing and Stabilization.

Laser systems:

Basics of tunable, ultrafast and power lasers; Gas lasers: He-Ne, He-Cd, Ar, Kr ion, CO₂, Excimer lasers; Solid state lasers: Diode pumped solid state lasers, Lamp pumping and thermal issues; Ruby, Nd-YAG, Fibre lasers; Semiconductor lasers: Laser materials, Laser structure, Frequency control of laser output, Modern diode laser, Quantum cascade lasers, p-Ge lasers, Vertical-cavity surface-emitting laser.

Applications of laser:

Laser cooling; Laser barcode scanner, Laser trimming, Cutting, Welding, Drilling and Tracking, Pattern formation by laser etching; LIDAR; Laser-tissue interaction, Laser surgery; Holography, Interferometry, Microscopy.

Nonlinear optics & Linear optics:

Homogeneous isotropic media, wave propagation in linear isotropic media, anisotropic materials, tensor nature of anisotropy, harmonic oscillator: optical response, nonlinear optical susceptibility: susceptibility tensor, wave propagation in nonlinear media, second harmonic generation.

Light scattering

Extinction, scattering, and absorption cross sections, optical theorem, light scattering from small objects, Mie theory, Mie scattering, Rayleigh scattering, importance of scattering and extinction in optical experiments.

Optical properties of materials: Complex dielectric function and refractive index, optical properties of metals, permittivity of metals, damping constant, optical properties of semiconductors, optical properties of semiconductor nanocrystals: quantum dots, excitons, optical properties of novel materials like graphene and topological insulators.

Term Paper (19PH5307)

Solid State Physics-2 Lab (19PH5308)

Lab session no	List of Experiments
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- 1 Youngs modulus by uniform bending method
- 2 Creep behavior of a metal wire
- 3 Lattice Dynamics
- 4 Energy loss of magnetic materials by tracing B-H curve
- 5 Curie temperature of a Ferroelectric material
- 6 Dielectric constant of a solid
- 7 Specific heat of a solid (Graphite)
- 8 Specific heat of a metal (Brass) using Lee's Method
- 9 Velocity of Ultrasonic waves in a given liquid
- 10 Density and Viscosity measurement of liquids
- 11 Measurement of numerical aperture of optical fiber
- 12 Optical fiber loss
- 13 Susceptibility measurement using Quincke's method
- 14 Circular coil – Stewart Gee Galvanometer
- 15 Determination of electrical conductivity using two probe method
- 16 Preparation of polymer electrolyte using solution casting technique
- 17 Analysis of XRD spectra of polymer electrolytes
- 18 Preparation of cathode materials using hydro thermal method
- 19 Analysis of FT-IR spectra of polymer electrolytes
- 20 Preparation of cathode materials using solid state reaction method
- 21 Analysis of the cathode materials using XRD and SEM
- 22 Preparation of materials using spin coating method

Semester – 4 Courses Syllabus

Dissertation (19PH5401)

Electives

Elective-1

Experimental Techniques (19PH54E1)

Unit-1: Properties of Electromagnetic radiation, interaction of EM radiation with matter, absorption, scattering, diffraction, polarization, excitation and de-excitation. Experimental techniques and analysis of materials through X-ray scattering techniques: powder method, Laue method, crystal structure determination. Phase diagram determination X-ray diffraction. Atomic scattering and Geometrical structure factors. Factors influencing the intensities of diffracted beams. Powder X-ray diffractometer. Applications of XRD in materials.

Unit-2: Study of the morphology, aggregation, size and microstructure of ceramic materials using Optical microscope, quantitative phase analysis. Principle of electron microscopy. Construction and operation of Transmission Electron Microscope (TEM) and Scanning Electron Microscope (SEM), Atomic force microscopy (AFM). Electron diffraction by crystalline solids; selected area diffraction. Atomic Force

Microscope. Mechanism of image formation in SEM and its processing. Electron microprobe analysis (EDAX and WDS). Preparation of samples for electron microscopic studies. ESCA and PES.

Unit-3: Spectroscopic analysis of materials: Basic laws of spectroscopy and its application in micro analysis, Spectroscopic characterization techniques: Rutherford back scattering method, X-ray photoelectron Spectroscopy. Electrical Characterizations: Dielectric measurements, polarization-electric field measurements. Magnetic Characterization: M-H.

Unit-4: Nanoscale lithography techniques and technology, major methods of nanoscale lithography. Moore's Law. Lithography techniques (Photolithography, Electron-beam lithography, X-Ray Lithography). DTA, TGA and DSC with suitable examples of glass and ceramic materials. Vacuum Techniques: Physical vapour deposition, Chemical vapour deposition and Molecular beam Epitaxy method.

Text Books:

1. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 6th Ed., C.B.S. Publishers, New Delhi, 1991.
2. Metals Handbook Vol. 9, Characterization of Materials, 10th Ed., American Soc. of Metals, Metals Park, Ohio, 1986.
3. G.A. Higgerson, Experiments in Materials Technology, Affiliated East-West Press, 1973.
4. L.C. Azzarof, Elements of X-ray Crystallography, McGraw-Hill, New York, 1968.
5. M.V. Heimendahl, Electron Microscopy of Materials-An Introduction, Academic Press, 1980.

Basic Communication Theory (19PH54E2)

Amplitude Modulation

Generation and detection of AM wave-spectra-DSBSC, Hilbert Transform, Pre-envelope & complex envelope – SSB and VSB –comparison -Superheterodyne Receiver.

Angle Modulation

Phase and frequency modulation-Narrow Band and Wide band FM – Spectrum – FM modulation and demodulation – FM Discriminator- PLL as FM Demodulator – Transmission bandwidth.

Random Process

Random variables, Central limit Theorem, Random Process, Stationary Processes, Mean, Correlation & Covariance functions, Power Spectral Density, Ergodic Processes, Gaussian Process, Transmission of a Random Process Through a LTI filter.

Noise Characterization

Noise sources and types – Noise figure and noise temperature – Noise in cascaded systems. Narrow band noise – PSD of in-phase and quadrature noise –Noise performance in AM systems – Noise performance in FM systems – Pre-emphasis and de-emphasis – Capture effect, threshold effect.

Information Theory

Entropy – Discrete Memoryless channels – Channel Capacity -Hartley – Shannon law – Source coding theorem – Huffman & Shannon – Fano codes.

TEXT BOOKS:

- 1. J.G.Proakis, M.Salehi, "Fundamentals of Communication Systems", Pearson Education 2006.
- 2. S. Haykin, "Digital Communications", John Wiley, 2005.

REFERENCES:

- 1. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 3rd Edition, Oxford University Press, 2007.
- 2. B.Sklar, “Digital Communications Fundamentals and Applications”, 2nd Edition Pearson Education 2007
- 3. H P Hsu, Schaum Outline Series – “Analog and Digital Communications” TMH 2006
- 4. Couch.L., “Modern Communication Systems”, Pearson, 2001.

Elective-2

Physics of Nano Materials (19PH54E3)

Overview of quantum mechanics, concepts related to low-dimensional systems, wave-particle duality, Heisenberg principle, Schrödinger wave equation, Fermi-Dirac and Bose-Einstein distributions. Concepts related to electronic structure: direct lattice, reciprocal lattice, energy bands, direct and indirect band gap semiconductors, variation of energy bands with alloy composition, lattice mismatching, effective-mass, electron statistics

Heterojunctions, Type I and Type II heterostructures, classification of quantum confined systems, electrons and holes in quantum wells, surface to volume ratio in quantum confined systems, spherical cluster approximation, exterior and interior surface area. Electron states in heterostructures: electronic wave functions, energy subbands and density of electronic states in quantum wells, quantum wires, quantum dots, effective-mass mismatch in heterostructures

Coupling between quantum wells, super lattices, wave functions and density of states for super lattices, unit cell for quantum well, for quantum wire and for quantum dots, 2DEG. Transmission in nanostructures: tunneling in planar barrier, Resonant Tunnel diodes. Excitons: in bulk, in quantum structures and in heterostructures

Metal nanoclusters, magic numbers, geometric structures, electronic structure, bulk to nanotransition, magnetic clusters, semiconducting nanoparticles, rare-gas and molecular clusters. Carbon nanoparticles: CNTs, chiral vector, chiral angle, unit cell for CNTs. Bulk nanostructured materials: Solid disordered crystals, colloidal Photonic crystals

Text Books:

1. Nanotechnology-Molecularly Designed Materials: *G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.*
2. Nanotechnology Molecular Speculations on Global Abundance: *B.C. Crandall (MIT Press), 1996.*

Reference Books:

1. Quantum Dot Heterostructures: *D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.*
2. Nanoparticles and Nanostructured Films–Preparation, Characterization and Application: *J.H.Fendler (Wiley), 1998.*
3. Nanofabrication and Bio-system: *H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.*
4. Physics of Semiconductor Nanostructures: *K.P. Jain (Narosa), 1997.*
5. Physics of Low-Dimension Semiconductors: *J.H. Davies (Cambridge Univ. Press) 1998.*
6. Advances in Solid State Physics (Vo.41): *B. Kramer (Ed.) (Springer), 2001.*

Radar Systems and Satellite Communication (19PH54E4)

Radar Systems: Fundamental – A simple RADAR – overview of frequencies – Antenna gain Radar Equation – Accuracy and Resolution – Integration time and the Doppler shift- Designing a surveillance radar – Rader and surveillance – Antenna beam – width consideration – pulse repetition frequency – unambiguous range and velocity – pulse length and sampling – radar cross section – clutter noise-

Tracking Radar – Sequential lobbing – conical scanning – Monopoles Radar – Tracking accuracy and Process – Frequency Agility – Radar guidance

Signal and Data Processing: Properties of clutter – Moving Target Indicator Processing Shareholding – Plot extraction – Tract Association, Initiation and Tracking - Radar Antenna – Antenna parameters – Antenna Radiation Pattern and aperture distribution – Parabolic reflector – cosecant squared antenna pattern – effect of errors on radiation pattern – Stabilization of antennas.

Satellite Communication: Satellite System – Historical development of satellites – communication satellite systems – communication satellites – orbiting satellites – satellite frequency bands – satellite multiple access formats. Satellite orbits and inclination – Look angles, orbital perturbations, space craft and its subsystems – attitude and orbit control system – Telemetry, Tracking and Command – Power system – Transponder – Reliability and space qualification – launch vehicles.

Multiple Access Techniques: Time division multiple access – Frequency division multiple access – Code division multiple access – Space domain multiple access. Earth Station technology – Subsystem of an earth station – Transmitter – Receiver Tracking and pointing – Small earth station – different types of earth stations – Frequency coordination – Basic principles of special communication satellites – INMARSAT VSAT, GPS, RADARSAT, INTELST.

Text Books:

1. Understanding Radar Systems – Simon Kingsley and Shaun Quegan.
2. Introduction to Radar Systems – MI Skolnik
3. Satellite Communication – Robert M. Gagliardi
4. Satellite Communication – Manojit Mitra

Elective-3

Thin Film Technology (19PH54E5)

Preparation of Thin film Techniques: Preparation of Thin-films Kinetic aspects of Gases in a vacuum chamber - Classifications of vacuum ranges Production of vacuum - Pressure measurement in vacuum systems - Physical vapour deposition - Evaporation Techniques - Sputtering (RF & DC) - Pulsed Laser deposition-Liquid Phase Epitaxy- Vapour Phase Epitaxy- Molecular Beam Epitaxy.

Film growth technique and Kinetics: Film growth and measurement of thickness, Thermodynamics and Kinetics of thin film formation - Film growth – five stages - Incorporation of defects and impurities in films - Deposition parameters and grain size - structure of thin films - Microbalance technique - quartz crystal monitor photometric - Ellipsometry and interferometers - Measurement of rate of deposition using ratemeter - cleaning of substrate.

Thin film Characterization Techniques: Characterization, X-ray Diffraction(XRD) - SEM, Photoluminescence(PL) - Raman Spectroscopy, UV-Vis-IR Spectrophotometer – AFM - Hall effect – SIMS - X-ray Photoemission Spectroscopy (XPS) - Vibrational Sample Magnetometers, Rutherford Back Scattering (RBS).

Various Properties of Thin films: Properties of thin films Dielectric properties - Experimental techniques for dielectric film - annealing effect, effect of film thickness on dielectric properties – determination of optical constants – Experimental techniques for determination of optical parameters - Magnetic and mechanical properties - Hall effect compilations - Adhesion, stress, strength, Raleigh surface waves - Ferromagnetic properties of Thin films - Experimental methods for measurement of mechanical properties of thin films.

Text Books:

1. K.L. Chopra, Thin film phenomena, McGraw- Hill book company New York, 1969
2. LudminlaEckertova, ‘Physics of thin films’, Plenum press, New York 1977.

:3. A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi (1996).

Antenna Theory and Radio wave Propagation (19PH54E6)

Radiation and Antenna Fundamentals: Potential functions of electro-magnetic fields. Potential function for sinusoidal oscillations. Fields radiated by an alternating current element. Power radiated by a current element and radiation resistance. Radiation from a quarter wave monopole or a half wave dipole. EM field close to an antenna and far field approximation. Definition of an antenna. Antenna properties – radiation pattern, gain, directive gain and directivity. Effective area. Antenna beam width and band width. Directional properties of dipole antennas.

Antenna Arrays and Impedance: Two element array. Linear arrays. Multiplication of patterns and binomial array. Effect of Earth on vertical patterns. Mathematical theory of linear arrays. Antenna synthesis – Tchebycheff polynomial method. Wave polarization. Antenna terminal impedance. Mutual impedance between two antennas. Computation of mutual impedance. Radiation resistance by induced emf method. Reactance of an antenna. Biconical antenna and its impedance.

Frequency Independent (FI) Antennas and Methods of excitation and Practical Antennas Frequency Independence concept. Equiangular spiral. Log Periodic (LP) antennas. Array theory of LP and FI structures. Methods of excitation and stub matching and baluns. Folded dipole, loop antennas. Parasitic elements and Yagi-Uda arrays and Helical antenna. Complementary screens and slot antennas. Radiation from a rectangular horn antenna.

Radio Wave Propagation: Elements of Ground wave and Space wave propagation. Tropospheric propagation and Troposcatter. Fundamentals of Ionosphere. Sky wave propagation – critical frequency, MUF and skip distance.

Text Books:

1. “Electromagnetic waves and Radiating Systems” by E.C.Jordan and K.G.Balmain
2. “Antennas” by J. D. Kraus. (Second Edition)