DEPARTMENT OF PHYSICS AND ELECTRONICS

LACHOO MEMORIAL COLLEGE OF SCIENCE AND TECHNOLOGY (AUTONOMOUS)

JODHPUR

MEETING OF BOS-2017

ON MARCH 22, 2017

PROPOSED SYALLABUS FOR

UG: PHYSICS AND ELECTRONICS (2017-2020)

PG: PHYSICS (2017-2019)

ANUXURE –A3 (1)

PAPERS SCHEME

M.Sc. (PHYSICS)

(2017-2019)

I SEMESTER

1. MSPH111: CLASSICAL MECHANICS
2. MSPH112: MATHEMATICAL PHYSICS
3. MSPH113: COMPUTATIONAL PHYSICS
4. MSPH114: SEMICONDUCTOR DEVICES AND CIRCUITS

LAB-I

5. MSPH121: GENERAL LAB.

LAB-II

6. MSPH122: ELECTRONICS LAB.

II SEMESTER

1. MSPH211: DIGITAL ELECTRONICS AND MICROPROCESSOR
2. MSPH212: QUANTUM MECHANICS-I
3. MSPH213: SOLID STATE PHYSICS
4. MSPH214: STATISTICAL AND PLASMA PHYSICS

LAB- I

5. MSPH221: LASER LAB.

LAB- II

6. MSPH222: COMPUTATIONAL PHYSICS LAB.

III SEMESTER

1. MSPH311: ELECTRODYNAMICS
2. MSPH312: QUANTUM MECHANICS-II
3. MSPH313: NUCLEAR PHYSICS-I
4. MSPH314(A/B): SPECIAL PAPER-I

LAB-I

5. MSPH321: GENERAL LAB.

LAB-II

6. MSPH322: SPECIAL PAPER (A/B) LAB.

IV SEMESTER

1. MSPH411: NUCLEAR PHYSICS-II
2. MSPH412: ATOMIC AND MOLECULAR SPECTROSCOPY
3. MSPH413: NANOMATERIALS
4. MSPH414(A/B): SPECIAL PAPER-II

LAB-I

5. MSPH421: SPECIAL PAPER (A/B) LAB

LAB-II

6. MSPH422: PROJECT

- *SELECT ANY ONE GROUP FOR SPECIAL PAPERS*

GROUP-A ELECTRONICS

MSPH314(A): COMMUNICATION TECHNOLOGY

MSPH414(A): NETWORK ANALYSIS AND MICROWAVE ELECTRONICS

GROUP- B MATERIAL SCIENCE**

MSPH314(B): MATERIAL SYNTHESIS AND CHARACTERIZATION

MSPH414(B): THIN FILMS

** *DEPONDING UPON THE BUDGET ALLOCATED FOR LAB BY THE MANAGEMENT.*

ANUXURE -A3 (2)
SCHEME OF TEACHING AND EXAMINATION
MSc. PHYSICS I AND II YEAR (I-IV) SEMESTERS
(2017-2019)

“MSc. PHYSICS I SEMESTER”

Code	Description	Pd/w	Exam	CIA	ESE	Total
MSPH111	CLASSICAL MECHANICS	6	3	20	80	100
MSPH112	MATHEMATICAL PHYSICS	6	3	20	80	100
MSPH113	COMPUTATIONAL PHYSICS	6	3	20	80	100
MSPH114	SEMICONDUCTOR DEVICES AND CIRCUITS	6	3	20	80	100
MSPH121	GENERAL LAB	8	5	20	80	100
MSPH122	ELECTRONICS LAB	8	5	20	80	100
	Total					600

“MSc. PHYSICS II SEMESTER”

Code	Description	Pd/w	Exam	CIA	ESE	Total
MSPH211	DIGITAL ELECTRONICS AND MICROPROCESSORS	6	3	20	80	100
MSPH212	QUANTUM MECHANICS-I	6	3	20	80	100
MSPH213	SOLID STATE PHYSICS	6	3	20	80	100
MSPH214	STATISTICAL AND PLASMA PHYSICS	6	3	20	80	100
MSPH221	LASER LAB	8	5	20	80	100
MSPH222	COMPUTATIONAL PHYSICS LAB	8	5	20	80	100
	Total					600

"MSc. PHYSICS III SEMESTER"

Code	Description	Pd/w	Exam	CIA	ESE	Total
MSPH311	ELECTRODYNAMICS	6	3	20	80	100
MSPH312	QUANTUM MECHANICS-II	6	3	20	80	100
MSPH313	NUCLEAR PHYSICS-I	6	3	20	80	100
MSPH314	SPECIAL PAPER-I (A/B)	6	3	20	80	100
MSPH321	GENERAL LAB	8	5	20	80	100
MSPH322	SPECIAL PAPER LAB (A/B)	8	5	20	80	100
	Total					600

"MSc. PHYSICS IV SEMESTER"

Code	Description	Pd/w	Exam	CIA	ESE	Total
MSPH411	NUCLEAR PHYSICS-II	6	3	20	80	100
MSPH412	ATOMIC AND MOLECULAR SPECTROSCOPY	6	3	20	80	100
MSPH413	NANOMATERIALS	6	3	20	80	100
MSPH414	SPECIAL PAPER-II (A/B)	6	3	20	80	100
MSPH421	SPECIAL PAPER LAB	8	5	20	80	100
MSPH422	PROJECT	8	-	20	80	100
	Total					600

GRAND TOTAL OF MARKS OF MSC. PHYSICS (I-IV) SEMESTERS: 2400

ANUXURE- B3(1)

SYLLABUS OF MSc. I YEAR (I AND II SEMESTERS)

SUBJECT: PHYSICS

(2017-2018)

MSc. Physics (I Semester)

Paper I

MSPH111: CLASSICAL MECHANICS

Unit I

Langrangian Dynamics: Constraints, Generalized coordinates, Concept of virtual work, D'Alembert principle, Langrange equation from D'Alambert principle, Velocity dependent potential, Expression for kinetic energy of a system in terms of Generalized coordinates, Cyclic coordinates, Symmetry properties and conservation theorems.

Unit II

Hamiltonian dynamics: Hamiltonian function H and conservation of energy: Jacobi's integral and its significance, Hamilton's equation, Routhian.

Hamiltons variation principle, Derivation of Langrange equation, Extension of Hamilton's Principle, to non-holonomic system, A hoop rolling without slipping on an inclined plane, Modified Hamilton's Variation principle, Derivation of Hamilton's equation from variation principle, Δ- variations, Principle of least actions in various forms.

Unit III

The Two Body Central Force Problem: Central force and motion in a plane, Reduction of a two body central force to equivalent one body problem, Equation of motion and first integral, Differential equation for an orbit, Equivalent one dimensional problem and classification of orbits for some specific potential.

Integral power law potential, Virial theorem, Relation between kinetic and potential energy.

Keplers Problems: Equation of orbit and the kind of the orbit, Motion in time.

Unit IV

The kinematics of rigid body motion: Independent co-ordinate of a rigid body, Orthogonal transformation, Formal properties of transformation matrix, Eular angles, Eular's theorem, Finite rotation, Infinitesimal rotations (contact transformation).

Angular momentum, Moment of inertia tensor, Product of inertia, Inertia tensor, Principal moment of inertia: Principal axis, Kinetic energy of motion of a rigid body about a point.

Unit V

Canonical transformation and Hamilton Jacobi theory: Canonical transformation, Legendre transformation, Generating functions, Conditions for canonical transformation, Bilinear invariant condition.

Poisson's brackets, Langrange brackets, Invariance of Poission bracket under canonical transformation, Angular momentum Poission bracket relation.

Hamilton Jacobi equation for Hamilton's principal function, Harmonic oscillator problem by Hamilton Jacobi method, Hamilton's characteristic function.

Suggested Readings:

1. H. Goldsteen: *Classical Mechanics*, Narosa Publishing House, 2001.
2. N. C. Rana and P. S. Joag: *Classical Mechanics*, Tata Mc-Graw Hill, New Delhi, 1991.
3. J. C. Upadhyaya: *Classical Mechanics*, Himalaya Publishing, 2006.
4. P. V. Panat: *Classical Mechanics*, Narosa Publishing House, 2000.
5. S. L. Gupta, V. Kumar, H. V. Sharma: *Classical Mechanics*, Pragati Prakashan, Meerut, 2009.

MSc. Physics I Semester

Paper II

MSPH112: MATHEMATICAL PHYSICS

Unit I

Complex Variables: Analytical functions, Cauchy Riemann conditions, Cauchy's integral theorem, Cauchy's integral formula, Taylor and Laurent's Series expansions, Cauchy's residue theorem, Simple examples of contour integration.

Unit II

Fourier and Laplace Transforms: Fourier transform, Convolution theorem, Laplace transforms, Laplace transform of derivatives, Substitution properties of Laplace transform, Properties of gamma function, Error function and Dirac delta functions.

Unit III

Curvilinear Coordinates: Orthogonal coordinate systems, Gradient, Curl, Divergence and Laplacian in orthogonal coordinate systems, Spherical, Polar and Cylindrical co-ordinates, Poisson's and Laplace Equations, Green's theorem.

Probability Theory: Elementary probability theory, Random variables, Binomial, Poisson and normal distributions.

Unit IV

Coordinates Transformation in N- dimensional Space: Contravariant and covariant tensor, Jacobian, Relative tensor, Pseudo tensors (Example: charge density, angular momentum), Riemann space(Example: Euclidean space and 4D Minkowski space), Christoffel symbols, Transformation of Christoffel symbols, Covariant differentiation ,Ricci's theorem , Divergence, Curl and Laplacian tensor form, Stress and strain tensors, Hook's law in tensor form.

Unit V

Special Functions: Series solution of linear differential equations with variable coefficients, Legendre, Bessel, Hermite, Laguerre, Associated Laguerre polynomials and their generating functions, Recurrence relations, Orthogonal properties and Rodrigue's formula.

Suggested Reading:

1. B.D. Gupta: *Mathematical Physics*, Vikas Publication House, 1986.
2. H.K. Das: *Advanced Engineering Mathematics,* S. Chand Pub., 2008.
3. George Arfken and H.J. Weber: *Mathematical Physics*, Academic Press, 2005.
4. B.S. Rajput: *Mathematical Physics,* Pragti Prakashan, Meerut, 1997.
5. L.A. Pipes: *Applied Mathematics for Engineers & Physicists*, Mc-Graw Hill, 1970.
6. M.C. Potter and J.L Goldberg: *Mathematical Methods,* Prentice Hall of India, 1978.

M.Sc. Physics I Semester

Paper III

MSPH113: COMPUTATIONAL PHYSICS

Unit I

General Concepts of Programming : Algorithm, Flowchart, Programming language, High level and low level language, Compiler, Errors in programs and their removal, Data, Record and file.

Numeric Computing: Process of numeric computing, Characteristics of numeric computing, Significant digits, Accuracy, Precision, Types of errors, Absolute error and relative error, Errors propagations, Conditioning and stability, Iterative process and its convergence, Error estimation.

Unit II

Programming with FORTRAN: Constants and variables, Arithmetic operations, Built in functions, Input and output statements, FORMAT statement, Assignment statement, Expression, Relational and logical operator, Transfer of control, IF statements, GOTO statements, Do loop, Nested loop, Function and subroutines, COMMON and TYPE statement, Use of files, Writing and executing a FORTRAN program.

Unit III

Solution of Transcendental and Polynomial Equation in one Variable: Newton Raphson, Successive bisection, False position methods, Convergence of these methods.

Solution of Simultaneous Linear Equations: Gauss elimination method, Gauss elimination with pivoting, Gauss -Seidel method, Eigen value and Eigen vectors of matrices, Finding Eigen value and Eigen vector by Jacobi method and power method.

Unit IV

Solution of Ordinary Differentials Equations: Euler and Runga-Kutta Methods, Predictor-corrector method, Error estimates in these methods.

Numerical Differentiation: Differentiation of continuous function, Forward difference and central difference methods, Differentiations of tabulated functions

Numerical Integrations: Newton-Cotes method, Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Guass -Quadrature Method, Error estimates.

Unit V

Curve Fitting: Interpolation, Polynomial forms, Linear interpolation, Lagrange interpolation, Newton interpolation, Interpolation with equidistance points, Regression, Fitting linear equation, Least square regression, Fitting transcendental equation and polynomial Function.

Simulation Methods : Random numbers, Generation of random numbers, Monte Carlo method of numerical Integration, Introduction to simulation and simulation methods, Monte Carlo simulation method, Molecular dynamics method.

Suggested Reading:

1. E. Balagurusamy: *Numerical Methods*, TMH, New Delhi, 2006
2. Suresh Chandra: *Computer Application in Physics with FORTRAN, BASIC and C, 2nd edtion.*, Narosa Publishing House, New Delhi, 2006.
3. E V Krishnamurthy and S K Sen: *Numerical Algorithms: Computations in Science and Engineering, 11th edition,* Affiliated East-West Press Private Limit., New Delhi, 2007.
4. Seymour Lipschutz and Arthur Poe: *Theory and Problems of Pragamming with Fortran, Schaum's Outline Series,* Mc-Graw Hill Comp., Singapore, 1982.
5. R.C. Verma: *Computer Simulation in Physics*, Anamaya Publishers, New Delhi, 2004.
6. K. P. N. Murthy: *Monte Carlo Methods in Statistical Physics,* University Press, Hyderabad, 2004.

M.Sc. Physics I Semester

Paper IV

MSPH114: SEMICONDUCTOR DEVICES AND CIRCUITS

Unit I

Semiconductors: Elemental and compound semiconductor, Direct and indirect band gap, Non-degenerate and degenerate semiconductor, Generation and recombination of carriers, Types of recombination, Life time, Carrier drift and diffusion,

P-N Junction: Diffusion of impurities, Formation of junction, Electric field and potential, Junction capacitance, Diffusion capacitance, I-V characteristics, Switching and reverse recovery,

Unit II

Bipolar Junction Devices: Bipolar junction transistor, I-V characteristics, Switching action, Thyristors and UJT.

Metal semiconductor devices and FETs, Metal semiconductors barrier, Schottky effect, MOS diode, Energy band and I-V characteristics, MOSFET, LED: materials, Configurations and efficiency, LASER principle, Semiconductor and He–Ne lasers, PN junction solar cells,

Unit III

Feedback circuits: Feedback concept, positive and negative feedback, Barkhausen criterion, RC phase shift oscillator, Wein bridge oscillator, Hartley and Colpitt's oscillators, Nyquist criterion, Multivibrators: astable, monostable and bistable multivibrator, UJT relaxation oscillator, Schmitt Trigger, 555 timer based astable multivibrator,

Unit IV

Differential amplifier: Dual input, Balanced output differential amplifier, DC analysis, CMRR, constant currents bias, Level translator, Block diagram of typical OP-Amp, Characteristic of OP-Amp, Open and closed loop configuration, Inverting and non-inverting amplifiers, Voltage series feedback, Effect of feedback on closed loop gain, Input resistance, Bandwidth, Total output voltage, Applications of OPAMP- sign changer, scale changer, adder, integrator, differentiator.

Active Filters: first and second order Butterworth filters- Low pass, High pass, band pass and band reject filters

Unit V

Controlled Rectification and Voltage Regulation: Half wave and full wave, SCR control, Current rating of SCR, DIAC and TRIAC, DIAC-TRIAC phase control circuits, Voltage regulation using transistors, OP-AMP voltage regulator and regulator IC's.

Suggested Reading:

1. S.M. Sze: *Physics of Semiconductor Devices*, 2nd edition, Wiley India, 2004.
2. Ramkant A. Gayakwad: *Op-Amps and Linear Integrated Circuits*, PHI, New Delhi, 4th Ed., 2004.

3. John P. Mckelvey: *Solid State and Semiconductor Physics*, Krieger Pub Co., Harper International Edition, 1966.
4. A.G. Milnes: *Semiconductor Device and Integrated Electronics*, Van Nostrand Reinhold Publisher, 1980.
5. John Gower: *Optical Communication Systems*.PHI, New Delhi, 2nd Ed., 1993.
6. S.M. Zee: *Semiconductor Devices: Physics and Technology, 2nd Ed.,* Wiley India, 2002.
7. Allen Mottershed: *Electronic Devices and Circuits*, PHI, 2005.

MSc. Physics I Semester

Lab I

MSPH121: GENERAL LAB

List of Experiments:

1. To determine Plank's constant.
2. To determine paramagnetic susceptibility of given material (solution).
3. To determine Young's modulus of glass by Cornu's method.
4. To determine critical potentials with the help of Franck Hertz's experiment.
5. Study of coupled oscillators and finding the beat frequency.
6. Verification of Cauchy's Dispersion relation and calculation of Cauchy's constant.
7. To determine electrical resistivity of semiconductor by Four Probe method.
8. Study of absorption coefficient of $KMnO_4$.
9. Verification of Hartmann Dispersion relation.

MSc. Physics I Semester

Lab II

MSPH122: ELECTRONICS LAB

List of Experiments:

1. Study of effect of negative feedback on frequency response and input and output impedance of a BJT amplifier.
2. Study of wave shapes generated by astable multivibrator and determination time constant.
3. Study of differential amplifier and determination of CMRR.
4. Life time measurement by reverse recovery method.
5. Life time measurement by open circuit voltage decay (OCVD) method.
6. Sawtooth wave generation using UJT and determination of time constant.
7. Study of RC phase shift oscillator and measurement of time period.
8. First and second order low pass filters.
9. First and second order high pass filters.

MSc. Physics (II Semester)

Paper I

MSPH211: DIGITAL ELECTRONICS AND MICROPROCESSOR

Unit I

Digital Circuits: Logic gates, DeMorgans theorems, Universal Gates, Karnaugh Maps,
Various logic families: Transistor as a switch, Fan-in and Fan-out, Propagation delay, Tri-state logic, RTL, DTL, TTL, NMOS, CMOS.
Flipflops, One bit memory, RS flipflop, D flipflop, JK flipflop, Edge triggered, Preset and Clear.

Unit II

Counters and Registers: Asynchronous counters, up-down counter, Synchronous counter, MOD counters, Registers, Shift registers, Parallel loading, Universal shift registers, Applications of shift registers: Serial to parallel convertor, Parallel to serial convertor, Digital to analog convertor(D/A), Analog to digital convertor(A/D).

Unit III

Micro- Computer Hardware: Semiconductor memories, RAM, SRAM, DRAM, ROM, CPU: Instruction register and decoder, ALU, Control unit, Buses: Data, Address and control buses, Minimum microcomputer configuration, Interrupts, Concept of I/O mapped and memory mapped I/O.

Unit IV

8085 Microprocessor: Microprocessor 8085: Organization of 8085 microprocessor, Fetch and execution of instruction, Bus multiplexing, Interrupts : Maskable and non-maskable, Call locations, Interrupt service subroutine, Instruction set of 8085 Microprocessor: Data transfer group, Arithmetic group, Logical group, Branches group, Stack related instructions, Mnemonics and operation codes, Addressing modes: Direct, Indirect, Immediate, Indexed and relative, Assembly language programming.

Unit V

Data Transfer, Peripheral devices and Interfacing: Types of data transfer, Direct Memory Access, 8257 DMA controller, LED displays, I/O ports, 8255 programmable peripheral interface, 8253 programmable interval timer, 8279 keyboard-display interface, 8259 Programmable interrupt controller.

Suggested Reading:

1. A.P. Malvino and D.P. Leach: *Digital Principle and Applications 4th Ed.*, TMH, 1975.
2. B. Ram: *Fundamental of Microprocessors and Microcomputers*, Dhanpat Rai Publications, New Delhi, 2010.
3. R. S. Gaonkar: *Microprocessor Architecture Programming and Applications with the 8085*, CBS Publishers, 2011
4. M. Morris Mano: *Digital Design, 4th Ed.*, Pearson, 1992.

MSc. Physics II Semester

Paper II

MSPH212: QUANTUM MECHANICS-I

Unit I

General Formalism: Historical background, Stern-Gerlach experiment leading to concept of vector space, Ket and bra notation for vector space, Inner product, Norm of a vector, Orthonormality and linear independence, Basis and dimension, Outer product, Projection operator, Completeness (closure property), Hilbert space, Operator, Hermition operator, Eigen value and eigen function, Representation theory, Change of basis, Unitary operator, Matrix elements, Unitary transformation, Diagnolisation, Coordinate and momentum representation.

Unit II

Measurements in Quantum Mechanics: Expectation values, Compatible and incompatible observable, Base kets as simultaneous eigen kets of maximal set of commuting observable, Examples, Heisenberg uncertainty principle, Gaussian wave packet, Schrödinger picture, Heisenberg picture and interaction picture.

Invariance Principle and Conservation Laws: Symmetry and conservation laws, Displacement in space-conservation of linear momentum, Displacement in time –conservation of energy, Rotations in space-conservation of angular momentum, Space- inversion parity.

Unit III

Solution of Schrodinger Equation: One dimensional simple harmonic oscillator: Eigen function and Eigen value by solving Schrödinger equation and also by operator method, Creation and annilation operators.

Operators for Orbital Angular Momentum: Orbital angular momentum operators L^2, L_x, L_y and L_z, Spherical harmonics, Solution of Schrödinger equation for Hydrogen atom-energy levels and stationary state wave functions.

Unit IV

Angular Momentum: Spin angular momentum and total angular momentum, Ladder operators, Matrix representation of Operators J_x, J_y, J_z, and J^2, Pauli spin matrices, Addition of two angular momentums, Clebsch- Gorden coefficients, Selection Rules and simple applications.

Unit V

Approximation Methods: WKB approximation: Principle, WKB wave function, Criterion for the validity of the approximation, Connection formulas, Applications to the one dimensional bound system, Penetration of potential barrier. Variational method: Principle and applications to linear harmonic oscillator, Helium atom. Time independent perturbation theory: Non degenerate case, Application to anharmonic oscillator (X^4) and linear harmonic oscillator, Degenerate case: Application to linear Stark effect and Zeeman effect in the Hydrogen atom.

Suggested Reading:

1. J.J. Sakurai: *Modern Quantum Mechanics,* Addison Wesley, 2010.
2. V.K. Thankappan: *Quantum Mechanics, 2nd edition,* New Age International (P) Limited, Publishers, New Delhi, 2010.
3. A. Ghatak and S. Loknathan: *Quantum Mechanics: Theory and Application*, 4th edition, Macmillan, 1999.
4. D.J. Griffith: *Introduction to Quantum Mechanics,2nd edition,* Pearson Education, 2005.
5. L.I. Schift: *Quantum Mechanics, 3rd edition,* Mc-Graw Hill, 1968.
6. B.S. Rajput: *Advanced Quantum Mechanics*, Pragti Prakashan, Meerut, 1994.

MSc. Physics II Semester
Paper III
MSPH213: SOLID STATE PHYSICS

Unit I

Crystal Physics: Diffraction of waves by crystals, Reciprocal lattice and its application to diffraction technique, Laue, Powder and rotating crystal method, Crystal structure factor and atomic form factor.
Lattice Vibrations: Quantization of elastic waves, Phonon momentum and inelastic scattering by phonons.
Defects in Crystal: Point defects, Color centres, F-centres, Line defects and planer defects, Role of dislocations in crystal growth.

Unit II

Ferroelectrics: Classification of ferroelectric crystals, Theory of the ferroelectric displacive transitions: Polarization catastrophe, Soft optical phonon, Thermodynamics of ferroelectric transition, Ferroelectric domains, Antiferroelectric, Piezoelectric and pyroelectric material.
Phase Transition: First and second order transition, Long range order, Short range order and Bragg William model.

Unit III

Superconductivity: Basic phenomena, Meissner effect, Critical field, Type- I and Type- II superconductors, Heat capacity, Isotope effect, London equations, Coherence length, BCS theory of superconductivity, Flux quantization, Normal tunneling, dc and ac Josephson Effect, SQUID, High temperature superconductors.

Unit IV

Ferromagnetism: Weiss theory of ferromagnetism, Exchange interaction: Heisenberg model, Ferromagnetic domains, Origin of domains, Anisotropy energy, Bloch wall, Curie-Weiss law for susceptibility.
Antiferromagnetic, Ferrimagnetic order, Spin wave and magnons.

Unit V

Band Theory of Solids: Electrons in periodic lattice, Bloch theorem, Nearly free electron model, Tight-binding approximation, Fermi surface, de Hass-Van Alphen effect, Cyclotron resonance, Magneto-resistance, Quantum Hall effect.
Optical Properties: Refractive index, Electronic polarization, Optical absorption, Photoconductivity, Relationship between absorption coefficient and band gap recombination.

Suggested Reading:

1. C. Kittel: *Introduction of Solid State Physics*, 7th edition, John Wiley & Sons, 2004.
2. J.P. Shrivastava: *Elements of Solid State Physics, 2nd edition,* PHI, New Delhi, 2006.
3. L.V. Azaroff*: Introduction to Solids*, TMH edition, 1996.
4. N.W. Ashcroff N.D. Mermin: *Solid State Physics,* Holt, Rinehart and Winston, 1976.
5. A.J. Dekker: *Solid State Physics*, Prentice Hall, 1957.

MSc. Physics II Semester

Paper IV

MSPH214: STATISTICAL AND PLASMA PHYSICS

Unit I

Ensembles Theory and Boson gas: Micro canonical, Canonical and grand canonical ensembles, Phase spacing of classical system, Liouvilles theorem and its consequence, Quantum state and phase space, Chemical potential near absolute zero, Thermodynamics behavior of an ideal Boson gas, Bose-Einstein condensation, Liquid ^{4}He, Phase relation of Helium, Quasiparticles and superfluidity of ^{4}He, Superfluid phases of ^{3}He.

Unit II

Fermi Gas: Strongly degenerate Fermions gas and its thermodynamics, Ground state of Fermi gas, density of states, heat capacity of electron gas, Fermi gas in metals, Magnetism of free electron gas in weak and strong magnetic field, Landu diamagnetism, Ultra cold Fermi gas, White dwarf stars, Nuclear matter, Statistical model of an atom.

Unit III

Basic Properties and Occurrence of Plasma: Definition of plasma, Criteria for plasma behavior, Plasma oscillation, Quasi-neutrality and Debye Shielding, Plasma parameters, Natural occurrence of plasma, Astrophysical plasmas, Plasma in Magnetiosphere and Ionosphere, Plasma production and diagnostics, Thermal ionization, Saha equation, Brief discussion of methods of laboratory plasma production, Steady stage glow discharge, Microwave breakdown and induction discharge, Double plasma machine, Elementary ideas about plasma diagnostics, Electrostatic and magnetic probes.

Unit IV

Plasma Fluid Equations: Fluid equations; Convective, Two fluid and single fluid equations, Fluid drifts perpendicular to B diamagnetic drift.

Diffusion and Resistivity: Collision and diffusion parameters, Decay of a plasma by diffusion, Ambipolar diffusion, Diffusion across magnetic field, Collision in fully ionized plasma, Plasma resistivity, Diffusion in fully ionized plasmas, Solution of diffusion equation.

Unit V

Equilibrium and Stability: Hydromagnetic equilibria, Concept of magnetic pressure, Equilibrium of a cylindrical pinch, Benner pinch, Diffusion of magnetic field into plasma, Classification instabilities, Two stream instability, Gravitational instability. Resistive drift waves.

Suggested Reading:

1. R.K. Pathria: *Statistical Physics*, Elsevier India Pvt. Ltd., New Delhi, 2011.
2. F. Reif: *Statistical Physics (Vol. V)*, TMH, New Delhi, 2006.
3. David J. Griffiths: *Introduction to Electrodynamics*, Pearson Education, Delhi, 2003.

4. J.D. Jackson: *Classical Electrodynamics, 2nd edition*, Wiley Eastern Ltd., New York, 1985.
5. Satya Prakash: *Electromagnetic Theory and Electrodynamics,* Kedar Nath Ram Nath & Co., Meerut, 1995.

MSc. Physics II Semester

Lab I

MSPH221: LASER LAB

List of Experiments:

1. To determine and compare slit width from the study of Fraunhoffer Diffraction pattern.
2. To measure Brewster angle and hence to find the refractive index of given material.
3. To determine basic laser beam parameters of a given laser.
4. To study Magneto- Optic effect and hence to determine Verdet constant of a given material.
5. To study Electro- Optic effect and to determine the value of half wave voltage.
6. To study the Special Coherence using laser beam with double slit.
7. To Study the dissociation spectrum of Iodine.

MSc. Physics II Semester

Lab II

MSPH222: COMPUTATIONAL PHYSICS LAB

List of Experiments:

1. Determination of roots by Newton's Rapshon method.
2. Determination of roots by Bisection method.
3. Determination of roots by False- Position method.
4. Numerical integration by Trepozoidal method.
5. Numerical integration by Simpson's 1/3 method.
6. Numerical integration by Simpson's 3/8 method.
7. Integration by Guass-Quadature method.
8. Solution of differential equation by Runga- Kutta second order method.
9. Solution of differential equation by Runga- Kutta fourth order method.
10. Using Monte-Carlo methods integrate numerically the given function of one variable.
11. Curve fitting by least square method.

ANUXURE- B3(2)

SYLLABUS OF MSc. II YEAR (III AND IV SEMESTERS)

SUBJECT: PHYSICS

(2018-2019)

MSc. Physics II Semester

Paper I

MSPH311: CLASSICAL ELECTRODYNAMICS

Unit I

Electrostatics: Poisson and Laplace equations, Green's Theorem, Uniqueness of the solution with the Dirichlet or Neumann boundary conditions, Formal solutions of electrostatics boundary value problem with Green's function, Electrostatics potential energy density.

Boundary value problems in Electrostatics: Method of images, Point charge in the presence of grounded conducting sphere, Point charge in the presence of a charge insulated conducting sphere, Point charge near a conducting sphere at fixed potential, Conducting sphere in uniform electric field by method of images.

Unit II

Maxwell Equations, Vector and scalar potentials, Gauge transformations, Lorentz gauge, Coulomb gauge, Green functions for wave Equation, Derivation of equations of macroscopic electromagnetism, Poynting theorem and conservation of energy and momentum for a system of charged particles, Poynting theorem in linear dispersive media with losses, Poynting theorem for harmonic field.

Unit III

Radiating Systems, Multipole Fields and Radiation: Fields and radiation of a localized oscillating source, Electric dipole fields and radiation, Magnetic dipole and electric quadrupole fields, Center fed linear antenna, Multipole expansion of the electromagnetic fields, Properties of multipole fields, Energy and angular momentum of multipole radiation.

Collisions, Energy Loss and Scattering of Charged Particles: Energy transfer in a Coulomb collision between heavy incident particle and stationary free electron, Energy transfer to a harmonically bound charge, Thomson scattering, Cherenkov radiation.

Unit IV

Radiation by Moving Charges: Retarded time and retarded potential, Lienard–Wiechert potentials and fields for a moving point charge, Electromagnetic fields of a uniformly moving point charge, Total power radiated by an accelerated charge: Larmor's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Radiation emitted by a charge in arbitrary and extremely relativistic motion, Distribution in frequency and angle of energy radiated by accelerated charges.

Unit V

Dynamics of Relativistic Charged Particle: Lagrangian and Hamiltonian for a relativistic charged particle in external electromagnetic fields, Covariance of equation of motion, Euler-Lagrange equation, Motion of charged particle in uniform static magnetic field, Combined uniform static electric and magnetic fields, Motion of charged particle in non uniform static magnetic fields. Adiabatic invariance of flux through the orbit of particle, Generalization of the Hamiltonian: Canonical stress tensor.

Suggested Reading:

1. J.D. Jackson: *Classical Electrodynamics*, 2nd edition, John Wiley, 1985.
2. D.J. Griffith: *Introduction to Electrodynamics*, 3rd edition, Pearson Pub., New Delhi, 2003
3. Panofsky and Phillips: *Classical Electricity and Magnetism, 2nd edition*, Addison Wesley, 1962.
4. L.D. Landau and E.M. Lifshitz: *Classical Theory of Field, 4th edition*, Pergamon Press, 2003.
5. L.D. Landau and E.M. Lifshitz: *Electrodynamics of Continuous Media*, Pergamon Press, 1995.
6. J.R. Reitz, F.J. Milford R.W. Christry: *Foundation of Electromagnetic Theory*, 4th edition, Pearson Education, 2009.

MSc. Physics (III Semester)

Paper II

MSPH312: QUANTUM MECHANICS-II

Unit I

Theory of Scattering-I: The scattering experiments, Relationship of cross-section and wave function, Scattering amplitude; Partial wave analysis: Expansion of a plane wave in terms of partial waves, Scattering by central potential, Zero energy scattering; Scattering by a square well potential, Effective range, Resonant scattering.

Unit II

Theory of Scattering-II: Born approximation, Integral equation for scattering, Born's first approximation, Spherically symmetric potential, Criterion for validity of Born approximation, Scattering of electrons by atoms, Rutherford scattering.

Unit III

Identical Particles: Principle of indishtinguishability, Symmetry of wave functions, Spin and statistics, Pauli's exclusion principle, Construction of wave function of two electrons in L-S and j-j coupling, Allowed states, Ortho and para helium; Exchange force; Scattering of identical particles, Cases of spin half and spin zero particles.

Unit IV

Time Dependent Perturbation Theory: Constant perturbation, Transition to continuum, Fermi's golden rule, Harmonic perturbation, Radiative transitions; Adiabatic approximation, Sudden approximation.

Semi-Classical Theory of Radiation: Einstein coefficients, Atom field interaction, Interaction energy, Dipole matrix elements, Stimulated emission rate, Spontaneous emission rate, Selection rules.

Unit V

Relativistic Wave Equation: Klein Gordan equation, Dirac equation, Properties of Dirac matrices, Free Dirac particle, Equation of continuity, Non-relativistic limit, Spin-orbit coupling, Hole theory.

Suggested Reading:

1. J.J. Sakurai: *Modern Quantum Mechanics,* Addison Wesley, 2010.
2. V.K. Thankappan: *Quantum Mechanics, 2nd edition,* New Age International (P) Limited, Publishers, New Delhi, 2010
3. A. Ghatak and S. Loknathan: *Quantum Mechanics: Theory and Application,* 4th edition, Macmillan, 1999.
4. D.J. Griffith: *Introduction to Quantum Mechanics,2nd edition,* Pearson Education, 2005
5. L.I. Schift: *Quantum Mechanics, 3rd edition,* Mc-Graw Hill, 1968.
6. B.S. Rajput: *Advanced Quantum Mechanics,* Pragti Prakashan, Meerut, 1994.

MSc. Physics (III Semester)

Paper III

MSPH313: NUCLEAR PHYSICS-I

Unit I

General Properties of the Nucleus: Nuclear Size, Nuclear Spin, Parity of the Nuclei, Statistics of Nuclei, Magnetic dipole moment, Electric Quadrupole moment, Iso-spin, Size determination by Muonic X-ray Method and Life time of alpha emitters, Measurement of nuclear spin by Zeeman effect of hyperfine lines and by molecular spectra method, Magnetic dipole moment by Rabi's method.

Unit II

Nuclear Models: Introduction to nuclear models, Fermi gas model, Shell model of the nucleus: Harmonic potential, Spin-orbit interaction, Existence of shells, Application of shell model. Limitations of the Shell models, Collective model; Rotational and vibration states, Nilson model and explanation of ground states of the nuclei.

Unit III

Energy Spectrum of α and β rays: Discrete energy spectrum of α particles, Geiger-Nuttal's law, Gammow theory of α decay, Continuous spectrum of β particles, Pauli's neutrino hypothesis, Fermi theory of β decay, Coulomb correction, Screening effect, Kurie's plot, Selection rules in β decay, Orbital electron capture, Parity violation in β decay.

Unit IV

γ –ray spectrum: γ –ray spectra and nuclear energy levels, Irradiative transition in nuclei, Nuclear isomerism, Internal conversion, Internal pair creation, Selection rules of γ–ray transitions.

Mössbauer Effect: Nuclear resonance, Recoil energy, Thermal broadening, Doppler broadening, Heisenberg, Natural line width, Recoil free fraction, Velocity modulation, Isomer shift, Quadrupole splitting, Magnetic Hyperfine splitting.

Unit V

Basic interaction of various particles with matter: Interaction of Charge particles with matter; Bohr-Bethe formula, Interaction of γ–rays with matter: Photo electric, Compton effects and pair production,

Suggested Reading:

1. K.S. Krane: *Introductory Nuclear Physics*, Wiley, New York. 1987,
2. D. Griffiths: *Introduction to Elementary Particle Physics*, Harper and Row, New York. 1987,
3. R.R. Roy and B.P. Nigam: *Nuclear Physics*, New Age International, New Delhi, 1983.
4. I. Kaplan: *Nuclear Physics*, 2nd Edition, Narosa Pub. House, New Delhi, 1983.
5. H.A. Enge: *Introduction to Nuclear Physics*, Addison Wesley, London, 1975.
6. Y.R. Waghmare: *Introductory Nuclear Physics*, Oxford-IBH, New Delhi, 1981.
7. S. N. Ghoshal*: Atomic and Nuclear Physics*, Volume 2. , 2001.

8. J.M. Longo: *Elementary Particles*, Mc-Graw-Hill, New York, 1971.
9. R.D. Evans: *Atomic Nucleus*, Mc-Graw Hill, New York, 1955.
10. B.L. Cohen*: Concepts of Nuclear Physics*, TMH, New Delhi, 1971.
11. M.K. Pal: *Theory of Nuclear Structure*, Affl. East-West, Chennai, 1982.
12. W.E. Burcham and M. Jobes: *Nuclear and Particle Physics*, Addison-Wesley, Tokyo, 1995.

MSc. Physics (III Semester)

Paper IV: (Special Paper-I)

Group A: ELECTRONICS

MSPH314(A) : COMMUNICATION TECHNOLOGY

Unit I

Analog Communication: Modulation: Amplitude modulation-generation of AM waves, Demodulation of AM waves –DSBSC modulation, Generation of DSBSC waves, SSB modulation, Generation of SSB, Vestigial sideband modulation and frequency division multiplexing (FDM), Frequency modulation, Mathematical analysis, Generation of FM.

Demodulation: Demodulation of AM signals, Demodulation of FM signals: Foster seeley discriminator, Ratio detector

Unit II

Digital Communication: Sampling theorem, PAM Channel BW for a PAM signal, Natural sampling. Flat top sampling, Pulse code modulation, Quantization and the binary code, Dynamic range, Coding efficiency, Quantization error, Noise in PCM signals, Companding,

Digital modulation techniques: ASK, FSK, BFSK, BPSK, QPSK,

Unit III

Transmission Lines: Voltage and current equations of transmission lines, Characteristic impedance, Propagation constant, Reflection coefficient, VSWR, Impedance transformation, Smith chart, Impedance matching by single stub and double stub.

Optical Fiber : Light propagation in fibers, Total internal reflection, Numerical aperture of a given fiber, Fiber index profiles, step index and graded index fiber, Modes of propagation, Number of propagated modes in step-index fibers,

Unit IV

Radars and Satellite: Radar System: Radar block diagram and operation, Radar frequencies, Pulse consideration radar range equation, Minimum detectable signal, Receiver noise, Signal to noise ratio, Integration of radar pulses, Radar cross section, Pulse repetition frequency, Pulsed radar system, Doppler’s effect, CW Doppler Radar system, Moving target Indicator principle, FM radar.

Satellite Communication: Orbital satellites, Geo- stationery satellite, Orbital patterns, Look angles, Orbital spacing, Satellite systems link modules.

Unit V

Data Communication and Networking: Elements of LAN, WAN, MAN, Network topologies: STAR, BUS and RING network, Network Models: Layered tasks, OSI model, Layers in the OSI model, TCP/IP protocol suite, Switching: Concept of switching, circuit-switched networks, Datagram networks, Network switching, Addressing, Efficiency, Error Detection and Correcting Codes: Types of errors, Redundancy, Block coding, Hamming codes, Cyclic codes: Cyclic Redundancy Check, Hardware Implementation, Polynomials, Parity generation and detection,

Books Suggested:

1. Wayne Tomasi*: Introduction to Data Communication and Networking, 1st Ed.*, Pearson 2007.
2. Forouzan: *Data Communication and Networking, 4th Ed.*, TMH, 2006.
3. Roddy and Coolen: *Electronic Communication, 4th Ed.*, PHI, 2004.
4. Anokh Singh: *Principles of Communication Engineering,* S. Chand & Company, 2nd Ed. 2006.
5. Wayne Tomasi: *Advanced Electronic Communication System*, Pearson, 2009.

MSc. Physics (III Semester)

Paper IV: (Special Paper-I)

Group B: MATERIAL SCIENCE

MSPH314(B): MATERIAL SYNTHESIS AND CHARACTERIZATION

UNIT I

Introduction to Crystal Growth, Morphology of crystals, Various Crystal Growth Processes: Driving force, Rate-determining process, Vapour Growth: Step velocity, Mechanism of two-dimensional nucleation growth, Mechanism of spiral growth, Growth of a Crystal in a Solution: Solvation effects and growth rates.

UNIT II

Solid States and Solution Routes: Mechanical mixing, Grinding, Solid solution technique, Combustion method, Top seeded solution growth; Sol-gel techniques; Hydrothermal, Melt methods: Czechorlskii methods, Skull melting, Electro-chemical, Sono-chemical and Photo-chemical synthesis.

Unit III

X-ray, Electron and Neutron Diffraction Methods: XRD equipment, Powder method, Debye-Scherrer camera, Examination of typical XRD pattern, Crystal structure determination, Indexing XRD pattern, Scherrer formula for estimation of particle size, Lattice parameters calculations and other uses, Electron diffraction and neutron diffraction.

Unit IV

Basics of Thermal Analysis Techniques: TGA, DTA, DSC principles and applications.
Electron Imaging Techniques and their Applications: Principle and working of SEM, TEM, AFM and sample preparations.

Unit V

Spectroscopic Techniques: Mass spectroscopy, Principle and applications, Secondary ions mass spectroscopy, Special surface techniques: Electron spectroscopy for chemical analysis (ESCA), Ultraviolet photo electron spectroscopy (UPS), X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES).

Suggested Reading:

1. Ichiro Sunagawa: *Crystals: Growth, Morphology and Perfection*, Cambridge University Press, Cambridge, 2005.
2. J. W. Mullin: *Crystallization*, Elsevier Butterworth-Heinemann, London, 2004.
3. J. C. Brice: *Crystal Growth Processes*, John Wiley and Sons, New York, 1986.
4. H. H. Willard*: Instrumental methods of Analysis*, CBS Publishers, 1986.
5. B. D. Cullity: *Elements of X-ray Diffraction*, Addison Wesley Publishing Co., 1967.

6. Sam Zhang, Lin Li and Ashok Kumar: *Materials Characterization Techniques*, CRC Press, 2008.
7. Yang Leng: *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*, Wiley & Sons, 2008.
8. Elton N. Kaufmann: *Characterization of Materials, Vol.1*, Wiley & Sons, 2003.
9. R.A. Laudise: *Growth of Single Crystals*, Prentice Hall, 1973.
10. G. Dhanaraj, K. Byrappa, V. Prasad and M. Dudley (Eds.), *Springer Handbook of Crystal Growth*, Springer Verlag, 2010.

MSc. Physics (III Semester)

Lab-I

MSPH321: GENERAL LAB.

List of Experiments:

1. To study of the characteristics of a GM tube and determination of its operating voltage, Plateau length and Slope.
2. Verification of inverse square law for gamma rays.
3. Study of nuclear statistics.
4. Linear and mass attenuation co-efficient using gamma/beta ray source.
5. Estimation of efficiency of G.M. detector for gamma and beta ray source.
6. Study of energy resolution characteristics of a scintillation spectrometer as a function of applied high voltage and to determine the best operating voltage.
7. Study of Cs-137 spectrum and calculation of FWHM and resolution for a given scintillation detector.
8. Study of Co-60 spectrum and calculation of resolution of detector in terms of energy.
9. Energy calibration of gamma ray spectrometer (study of linearity).
10. Calculation of unknown energy of a radioactive isotope.
11. Variation of energy resolution with gamma energy.
12. Study of Hall effect in semiconductor crystals.

MSc. Physics (III Semester)

Lab-II

MSPH322: ELECTRONICS LAB.

List of Experiments:

1. Study of RC phase shift oscillator.
2. Study of square wave generator.
3. Study of Schmitt trigger.
4. Study of flip flops.
5. Study of half adder and full adder.
6. Study of half and full subtractor.
7. Study of shift registers.
8. Study of counters.
9. Study of MOD counters.
10. Assembly language programming on 8085 microprocessor: Data transfer using direct and indirect addressing, Addition, Subtraction.
11. Assembly language programming on 8085 microprocessor: Multiplication, Division, Array Addition, Largest and smallest from a set of numbers.

MSc. Physics (IV Semester)

Paper I

MSPH411: NUCLEAR PHYSICS-II

Unit I

Nuclear Forces: Two body problem, Ground state of deuteron, Magnetic moment, Quadruple moment, Tensor forces, Meson theory of nuclear forces, Yukawa potential, Nucleon-nucleon scattering, Low energy n-p scattering, Effective range theory, Spin dependence, Charge independence and charge symmetry of nuclear forces.

Unit II

Nuclear Reactions: Energetic of nuclear reactions, Reaction dynamics, Q-value equation, Scattering and reaction cross sections, Compound nucleus, Reciprocity theorem, Breit-Wigner one level formula, Resonance Scattering, Continuum theory, Optical model.

Unit III

Neutron Physics and Reactor Physics: Neutron production, Slowing down power and moderating ratio, Neutron detection, Mass and energy distribution of nuclear fragments, Four factor formula, Reactor operations, Power and breeder type reactors.

Nuclear Fusion: Introduction, Thermonuclear reactions and energy production, Fusion in hot medium, Progress in fusion power production, Stellar burning.

Unit IV

Nuclear Accelerators: Particle accelerators: Linear accelerators, Cyclic accelerators, Fixed target machines and colliders, Synchrotron: Principle of phase stability, Synchrotron radiations.

Basic principles of particle detectors: Solid state and semiconductor detectors, Cherenkov counter, Scintillation Counters, Spark Chamber.

Unit V

Particle Physics: Classifications of elementary particles, Isospin, Isospin quantum numbers, Strangeness and hyper charge, Hadrons, Baryons, Leptons, Invariance principles and symmetries, Invariance under charge-parity(CP), time(T) and CPT, CP violation in neutral K-meson decay, Tau-Theta puzzle, Feynman diagrams, Quark model, SU(3) symmetry, Gell-Mann-Nishijma formula, Neutrinos of different flavour, Charm, Bottom and Top quarks, QCD formulated, Evidence for gluon field.

Suggested Reading:

1. K.S. Krane: *Introductory Nuclear Physics*, Wiley, New York. 1987.
2. D. Griffiths: *Introduction to Elementary Particle Physics*, Harper and Row, New York. 1987.
3. R.R. Roy and B.P. Nigam: *Nuclear Physics*, New Age International, New Delhi, 1983.
4. I. Kaplan: *Nuclear Physics*, 2^{nd} Edition, Narosa, New Delhi, 1983.

5. J.S.Lilley, John Wiley & Sons Ltd., UK, 2001.
6. S. N. Ghoshal: *Atomic and Nuclear Physics*, Volume 2. , 2001.
7. R.D. Evans: *Atomic Nucleus*, Mc-Graw Hill, New York, 1955.
8. B.L. Cohen: *Concepts of Nuclear Physics*, TMH, New Delhi, 1971.
9. M.K. Pal: *Theory of Nuclear Structure*, Affl. East-West, Chennai, 1982.
10. W.E. Burcham and M. Jobes: *Nuclear and Particle Physics*, Addison Wesley, Tokyo, 1995.

MSc. Physics (IV Semester)

Paper II

MSPH412: ATOMIC AND MOLECULAR SPECTROSCOPY

Unit I

Atomic Spectroscopy: General discussion in Hydrogen spectra, Relativistic correction to spectra of Hydrogen atom, Spectra of monovalent atoms, quantum defect, penetrating and non-penetrating orbits, Introduction to electron spin, Spin-orbit interaction and fine structure, Spectra of divalent atoms: Singlet and triplet states of divalent atoms, L-S and j-j coupling, Branching rule, Hyperfine structure in spectra of monovalent atoms.

Unit II

Microwave Spectroscopy: Pure rotational spectra of diatomic molecules, Isotopic effect, Non-rigid rotator, Polyatomic molecules, Study of linear molecules and symmetric top molecules, Stark effect, Quadrupole hyperfine interaction, Microwave spectrometer, Information from rotational spectra.

Unit III

Infrared Spectroscopy: Vibrational spectroscopy of diatomic and simple polyatomic molecules, Harmonic Oscillator, Anharmonic Oscillator, Rotational vibrators, Normal modes of vibration of polyatomic molecules, IR spectrometer: FTIR Spectrometer, Applications of infrared spectroscopy: H_2O and N_2O, CO_2 molecules

Unit IV

Raman Spectroscopy: Raman effect, Classical and Quantum theory of Raman effect, Vibrational Raman spectra, Rotational Raman spectra, Vibrational-Rotational fine structure, Raman Spectrometer, Structure determinations from Raman and Infra-red spectroscopy.

Electronic Spectra: Electronic structure of diatomic molecules, Intensity of spectral lines, Frank-Condon principle, Dissociation energy and dissociation products, Rotational fine structure of electronic-vibration transitions.

Unit V

NMR and ESR Techniques: Theory of NMR, Relaxation effect, Bloch equations, Theory of dipolar interaction and chemical shifts, Indirect spin-spin interactions, Experimental set up of NMR, Applications of NMR to quantitative measurements (Idea only).

ESR: Quantum mechanical treatment of ESR, Nuclear interaction and hyperfine structure, Relaxation effects, ESR spectrometer, Applications of ESR method.

Suggested Reading:

1. Willard, Merritt, Dean, Settle: *Instrumental Methods of Analysis*, CBS Publishers & Distributors, Delhi, 6th Ed. 1986.
2. Colin N. Banwell and Elaine M. McCash: *Molecular Spectroscopy*, Mc-Graw Hill College; 4th Sub. Ed., 1994.
3. B. H. Bransden and Joachain: *Physics of Atoms and Molecules*, Longman, 1983.
4. V. Rajendran and A. Marikani: *Applied Physics*, TMH publication, 4th Ed., 2002.
5. P. F. Bernath: *Spectra of Atoms and Molecules*, Oxford University Press, 1995.
6. Raymond Chang: *Basic Principles of Spectroscopy*, Mc-Graw Hill, 1971.

7. P. W. Atkins: *Molecular Quantum Mechanics*, Oxford University Press, 1983.
8. B. B. Laud: *Lasers and Non-Linear Optics*, Wiley Eastern Ltd., 1991.
9. H. E. White: *Introduction to Atomic Spectra,* Tata Mc-Graw Hill. 1934.
10. G. Herzberg: *Molecular Spectra and Molecular Structure* Vol. 1, 2 & 3, Krieger Publishing Company, Malabar, 1989 & 1991.
11. D. A. Long: *Raman Spectroscopy*, Mc-Graw Hill, 1977.
12. G. M. Barrow: *Introduction to Molecular Spectroscopy*, Mc-Graw Hill, Tokyo, 1962.
13. J. M. Brown: *Molecular Spectroscopy*, Oxford University Primer, 1998.
14. J. M. Holias*:* *Modern Spectroscopy*, John Wiley & Sons, England, 1987.

MSc. Physics (IV Semester)

Paper III

MSPH413: NANOMATERIALS

Unit I

Introduction: Nano size scale, History of Nanotechnology, Quantum Mechanics and Fluctuation in nanostructure systems, Surface area to volume ratio, Surface energy, chemical potential as a function of surface curvature, Electrostatic stabilization and Steric stabilization, Idea of zero, one and two dimension nanostructures, Vacancies and dislocations in nanocrystals, Effect of nanoscale dimensions on various properties: Structural, Thermal, Chemical, Mechanical, Magnetic, Optical and electronic properties .

Unit II

Structure and Phase Transitions in Nanocrystals: Introduction, Crystalline phase transitions in nanocrystals: Phase transitions and grain size dependence, Elementary thermodynamics of the grain size dependence of phase transitions, Influence of the surface or interface on nanocrystals, Modification of transition barriers, Geometric evolution of the lattice in nanocrystals: Grain size dependence, Theory , Influence of the nanocrystal surface or interface on the lattice parameter, Continuous variation of the crystal state within nanocrystals .

Unit III

Synthesis of Nanomaterials: Physical methods: High energy ball milling, Melt mixing, Ion implantation, Lithography: Photolithography, Electron beam lithography, X-ray lithography, Chemical methods: Colloidal and sol-gel methods, Microwave method, Other methods: Methods for templating the growth of nanomaterials, Self-assembly and self-organization, Bio-induced nanomaterials (using microorganism and plant extract).

Unit IV

Physical Properties of Nanomaterials: Melting point and lattice constants, Mechanical properties, Optical properties; Surface Plasmon effect, Quantum size effect, Electrical conductivity; Surface Scattering, Change of Electronic structure, Quantum Transport, Effect of microstructure, Ferroelectric and dielectrics, Superparamagnetism.

Unit V

Applications of Nanomaterials: Application in molecular and nano-electronics, Biological applications (imaging, drug delivery), Quantum well and quantum dot devices, Energy application of nanomaterials; Photochemical cell, Lithuim –ion battery, Hydrogen storage and thermo-electrics, Environmental application, Photonic crystals.

Suggested Reading:

1. Guozhong Cao and Ying Wang: *Nanostructures and Nanomaterials: Synthesis, Properties and Applications, 2nd Ed.*, World Scientific, Singapore, 2011.
2. S.M. Lindsay: *Introduction to Nanoscience*, Oxford University Press, New York, 2010.
3. B.K. Parthasarthy (Edited): *Nanoscience and Nanotechnology*, Isha Books, Delhi, 2007.
4. Mark Ratner and Daniel Ratner: *Nanotechnology: A Gentle Introduction to Next Big Idea*, Pearson Education, 2008.
5. Gregory Timp (Edited): *Nanotechnology*, Springer, New York, 1999.

6. Charles P. Poole Jr. and Frank J. Owens: *Introduction to Nanotechnology*, Wiley Interscience, 2003.
7. Catherine Brechignac, Philippe Houdy and Marcel Lahmani, Spinger Berlin Heidelberg: *Nanomaterials and Nanochemistry*, New York, 2006.
8. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan (Edited): *Nanoscale Science and Technology*, John Wilet & Sons Limited, England, 2005.
9. Yury Gogotsi (Edited): *Nanomaterials Handbook*, CRC, Taylor & Francis, New York, 2006.

MSc. Physics (IV Semester)

Paper IV: (Special Paper-II)

Group A: ELECTRONICS

MSPH414(A): NETWORK ANALYSIS AND MICROWAVE ELECTRONICS

Unit I

Network Analysis and Laplace Transform Method: Analysis of simple L, C, R –circuits by solving differential equations, Laplace transform method, transient and steady state AC response; Transform functions of step, Delayed step, Rectangular pulse, Impulse and ramp; Application to simple circuits.

Unit II

S-Plane Analysis: Transform impedance and admittance functions, Thevenin and Norton theorems, Two port networks, Driving point impedance, Transfer functions, Poles and zeros of network functions, Restrictions on poles and zeros of driving point impedance and transfer functions, Time domain response from pole zero configuration.

Frequency Response Plots: Magnitude and phase plots, Complex loci, Plots from s-plane phasors, Bode plots,

Unit III

Introduction: Microwave frequency bands; Limitations of conventional devices at microwave frequencies.

Wave Guides: Wave propagation between parallel planes, Modes of propagation, Rectangular and circular wave guides, Impedance concept in wave guide, Impedance measurement by VSWR, Measurement of dielectric constant at microwave frequency, Cavity resonator, Measurement of frequency.

Unit IV

Microwave Components: Scattering matrix, Phase shifters, Directional couplers; E-plane, H-plane and Hybrid Tees; Ferrite isolators, Circulator.

Microwave Tubes: Velocity modulation, Basic principles and characteristics of two cavity klystron and reflex klystron; Magnetrons; Slow wave structure, Helix traveling wave tube, Wave modes, Gain.

Unit V

Semiconductor microwave devices: Microwave tunnel diodes; HEMT; Transfer electron devices, Gunn effect, Principle and modes of operation; Read diode, IMPATT and TRAPATT; Varactor, Parametric converters, Manley Rowe relations, Up converter and negative resistance amplifier.

Suggested Reading:

1. S.Y. Liao: *Microwave Devices and Circuits,3rd Ed.*, Prentice Hall of India, 1992.
2. G. Kennedy: *Electronic Communication Systems*, Tata Mc-Graw Hill, 1991.
3. R.E. Collins: *Foundations of Microwave Engineering*, Mc-Graw Hill, 1981.
4. E. Jordan and K.G. Balmain*: Electromagnetic Waves and Radiating System*, Prentice Hall of India, 1968.
5. F.E. Terman*: Electronic and Radio Engineering 4th Ed..*, Mc-Graw Hill, 1957.
6. G.S. Raghuvanshi*: Microwave Engineering*, CL India, 2012.

MSc. Physics (IV Semester)

Paper IV: (Special Paper-II)

Group B: MATERIAL SCIENCE

MSPH414(B): THIN FILMS

Unit I

Preparation of Thin Films: Study of thin film vacuum coating unit, Construction and uses of vapor sources wire, Sublimation Furnaces and Crucible sources.

Physical Vapor Deposition: Hertz Knudsen equation, Mass evaporation rate, Knudsen cell, Evaporation of elements, Compounds, Alloys, Raoult's law, Electron beam, Pulsed laser, Ion beam evaporation, Glow Discharge and plasma.

Unit II

Sputtering: Sputtering mechanisms and yield, DC and RF sputtering, Magnetron sputtering, Bias sputtering, Reactive sputtering, Evaporation versus Sputtering, Hybrid and modified PVD processes-Ion plating, Reactive Evaporation, Ion beam assisted deposition.

Unit III

Chemical Vapor Deposition: Thermodynamics of CVD, Gas transport, Film growth kinetics, Thermal CVD, LPCVD, MOCVD, laser and Plasma-enhanced CVD processes.

Chemical Methods: Qualitative study of preparation of thin films by electroplating, Anodization, Spray pyrolysis, Electro-deposition, Sol-Gel and LB techniques.

Unit IV

Nucleation and Growth: Homo, heterogeneous nucleation, Capillarity theory, Nucleation rate, Atomistic and kinetic models of nucleation, Basic modes of thin film growth, Amorphous thin films.

Epitaxy: Homo, Hetero epitaxy, Lattice misfit and imperfections in epitaxial films, Epitaxy of compound semiconductors, Methods for depositing Epitaxial semiconductor thin films.

Unit V

Deposition Monitoring and Control: Microbalance, Crystal oscillator thickness monitor, Thickness measurement: Fringes of equal thickness (FET) method-Multiple beam interferometer, Fringes of equal chromatic order (FECO) method-Ellipsometry.

Scope of Devices and Applications: Thin film resistors, Thin film capacitors, Thin film field effect transistors, Thin film solar cells, Antireflection coatings.

Books Suggested:

1. Milton Ohring: The *Materials Science of Thin Films*, Academic Press, California 1992.

2. K. L Chopra: *Thin Film Phenomena*, Krigger publishing company, Huntington, New York 1979.

3. L.I. Maissel and R. Glange: *Hand Book of Thin Film Technology*, Mc-Graw Hill, New York, 1970.

4. Donald Smith: *Thin-Film Deposition: Principles and Practice*, Mc-Graw Hill, 1st Ed., 1995.

MSc. Physics (IV Semester)

Lab-I

Group A: ELECTRONICS

MSPH421(A): SPECIAL PAPER LAB

List of Experiments:

1. Characteristics of Reflex Klystron
2. Measurement of VSWR and impedance
3. Measurement of dielectric constant
4. Amplitude modulation and demodulation
5. Pulse amplitude modulation and demodulation
6. Optical fiber communication
7. A/D conversion
8. D/A Conversion
9. Pulse width modulation and demodulation

MSc. Physics (IV Semester)

Lab-I

Group B: MATERIAL SCIENCE

MSPH421(B): SPECIAL PAPER LAB

List of Experiments:

1. Experiments with introductory Nano Kit.(Understanding nano scaling and demonstrating atomic arrangement).
2. Experiments based on Nano TiO_2 Solar Cell Trainer Kit.(Four experiments).
3. Experiments based on ferro-fluid demonstrator. (Three experiments).
4. Measurement of dielectric constants at microwave frequency.
5. Experiments with lattice dynamics kit.
6. Study of Balmer lines in Hydrogen atom.
7. Study of electron spin resonance in a paramagnetic crystal and calculation of Lange-g-factor.
8. Study of Curie temperature in a ferroelectric crystal and determination of dielectric constant.
9. Measurements of various magnetic parameters using hysteresis loop tracer.
10. Measurement of dielectric constant of a liquid using LCRQ meter.

MSc. Physics (IV Semester)

Lab-II

MSPH422: PROJECT

All the students have to carry out a project. The project work may be experimental or theoretical. Each student has to carry out his individual project. At the end of the semester each student has to submit a report of the work. The assessment of the project work will be done by the presentation of the work by the students.

PRACTICAL EXAMINATION MARKING SCHEME

UG CLASSES: BSc. (I-VI) SEMESTER, PHYSICS LAB

MAX. MARKS 80

A)	EXPERIMENT:		**50**
	11. Formula and explanation of symbols used:	05	
	12. Diagram/Circuit Diagram:	05	
	13. Observations:	20	
	14. Calculations:	15	
	15. Results with units:	05	
B)	VIVA-VOCE:		**30**
C)	TOTAL:		**80**

PRACTICAL EXAMINATION MARKING SCHEME

UG CLASSES: BSc. (I-VI) SEMESTER, ELECTRONICS LAB

MAX. MARKS 80

A)	EXPERIMENT:		**50**
	1. Formula and explanation of symbols used:	05	
	2. Diagram/Circuit Diagram:	05	
	3. Observations:	20	
	4. Calculations:	15	
	5. Results with units:	05	
B)	VIVA-VOCE:		**30**
C)	TOTAL:		**80**

PRACTICAL EXAMINATION MARKING SCHEME

PG CLASSES: MSc. (I-IV) SEMESTER, PHYSICS LAB

MAX. MARKS 80

A) **EXPERIMENT:**		**50**
1. Formula or theory and explanation of symbols used:	05	
2. Block Diagram/ Diagram or Circuit Diagram:	05	
3. Observations:	20	
4. Calculations:	15	
5. Results with units and graphs:	05	
B) **VIVA-VOCE:**		**30**
C) **TOTAL:**		**80**

PROJECT:		**80**
1. CONTENTS:	20	
2. SEQUENCE OF CONTENT	20	
3. PROJECT REPORT	10	
4. PRESENTATION	30	
TOTAL MARKS:		**80**