# Scheme & Syllabus of M.Sc. (Applied Physics ) for 2015 and onward batches

## Semester 1

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | External | Internal | Total | |
| MPH-101 | Mathematical Physics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-102 | Classical Mechanics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-103 | Thermodynamics and Statistical Mechanics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-104 | Semiconductors and Electronic Devices | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-105 | Physics Lab-I | 0 | 0 | 6 | 100 | 50 | 150 | 3 |
| MPH-106 | Fundamental of Computer Programming | 2 | 0 | 4 | 100 | 50 | 150 | 3 |
| Total | | 18 | 4 | 10 | 600 | 300 | 900 | 26 |

## Semester 2

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | External | Internal | Total | |
| MPH-201 | Quantum Mechanics-I | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-202 | Condensed Matter Physics-1 | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-203 | Atomic &Molecular Physics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-204 | Digital Electronics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-205 | PhysicsLab-II | 0 | 0 | 6 | 100 | 50 | 150 | 3 |
| MPH-206 | Computational Numerical Analysis | 2 | 0 | 4 | 100 | 50 | 150 | 3 |
| Total | | 18 | 4 | 10 | 600 | 300 | 900 | 26 |

# Scheme & Syllabus of M.Sc. (Applied Physics )

## Semester 3

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | External | Internal | Total | |
| MPH-301 | Quantum Mechanics-II | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-302 | Condensed Matter Physics -II | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-303 | Nuclear Physics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-304 | Classical Electrodynamics | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-305 | Physics Lab-III | 0 | 0 | 6 | 100 | 50 | 150 | 3 |
| Total | | 16 | 4 | 6 | 500 | 250 | 750 | 23 |

## Semester 4

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | External | Internal | Total | |
| MPH-401 | Physics of Nano Materials | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| MPH-402 | Synthesis and Characterization of Materials | 4 | 1 | 0 | 100 | 50 | 150 | 5 |
| | Dissertation* | 6 | | | 300 | 150 | 450 | 20 |
| Total | | 14 | 2 | 0 | 500 | 250 | 750 | 30 |

**NOTES:**

1. Three alphabet course code MPH stands for M.Sc. Physics.
2. Each lecture is of one hour duration.

***It will be an integrated dissertation, involving a maximum of 05 students in each group. The components of the Dissertation are as follows;**

- **Pre-submission Seminar (Internal Evaluation) (Satisfactory / Unsatisfactory)**
- **Thesis (Internal Evaluation) (150 Marks)**
- **Presentation (External Evaluation) (300 Marks)**

**Paper MPH-101**
**MATHEMATICAL PHYSICS**

**M. Marks External Exam: 100 55 Hrs. (4L+1T Hrs./week)**

**1. Elements of complex analysis:** Introduction, Laurent series-poles, residues and evaluation of integrals; Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals.Elementary ideas about tensors, Dispersion relation.
**10 lectures**

**2. Fourier Analysis, Laplace Analysis & Inverse Laplace Analysis:** Fourier series of periodic functions, even and odd functions, half range expansions and Fourier series of different wave forms, complex form of Fourier series and practical harmonic analysis. Fourier transforms of various standard functions. Laplace transforms of various standard functions, properties of Laplace transforms and inverse Laplace transforms and Inverse Laplace Analysis.
**15 lectures**

**3. Differential Equations:** Linear differential equations with constant coefficients, Cauchy's homogeneous linear equation, Partial differential equations of theoretical physics, separation of variables, singular points, series solutions, second solution.
**8 lectures**

**4. Special Functions:** Dirac delta function, Gamma function, Beta function. Besselfunctions of first and second kind, Generating function, integral representation and
recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality, Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.
**14 lectures**

**5. Group Theory:** Definition of a group, Multiplication table, Conjugate elements and classes of groups, directs product, Isomorphism, homeomorphism, permutation group, Definitions of the three dimensional rotation group and SU(2), O(3);. **7 lectures**

**Instructions for paper setters and candidates:**
I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all including the Compulsory question.
III. All questions carry equal marks.

**Suggested Books**
1. Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, San Diego).
2. Mathematical Physics: P.K. Chattopadhyay (Wiley Eastern, New Delhi).
3. Mathematical Physics : A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan,India, Delhi).
4. Mathematical Methods in the Physical Sciences – M.L. Boas (Wiley, New York).
5. Special Functions : E.D. Rainville ( MacMillan, New York).
6. Mathematical Methods for Physics and Engineering : K.F.Riley, M.P.Hobson and S.J. Bence (Cambridge University Press, Cambridge).
7. Advanced Mathematical Physics by Erwin Kreyszig

**Paper MPH-102**

**CLASSICAL MECHANICS**

**M. Marks External Exam: 100 55 Hrs. (4L+1T Hrs./week)**

1.**Lagrangian Formulation:** Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity- dependent forces and the dissipation function, Applications of Lagrangian formulation. **10 lectures**

**2. Hamilton's Principles:** Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to non-holonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.
**10 lectures**

**3.Rigid Body Motion:** Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.
**12 lectures**

**4.Small Oscillations:** Eigen value equation, Free vibrations, Normal Coordinates,Vibrations of a tritomic molecule. **5 lectures**

**5. Hamilton's Equations:** Legendre Transformation, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variation principle, Principle of least action.
**8 lectures**

**6. Canonical Transformation and Hamilton-Jacobi Theory:** Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom.
**10 lectures**

**Instructions for paper setters and candidates:**

I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all including the Compulsory question.
III. All questions carry equal marks.

**Suggested Books**

1. Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi).
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi).
3. Analytical Mechanics : L.N. Hand and J.D. Finch (Cambridge University Press, Cambridge)
4. Mechanics: L.D. Landau and E.M. Lifshitz (Pergamon, Oxford).
5. Classical Mechanics: N.C. Rana and P.J. Joag (Tata McGraw Hill, New Delhi).

**Paper MPH-103**
**THERMODYNAMICS & STATISTICAL PHYSICS**
**M. Marks External Exam: 100 55 Hrs. (4L+1T Hrs./week)**

**1. Basics of Thermodynamics:** Laws of thermodynamics and their consequences; Thermodynamic potentials, Maxwell relations; Chemical potentials, Phase equilibria.
**8 lectures**

**2. The Statistical Basis of Thermodynamics:** The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.
**10 lectures**

**3. Ensemble Theory:** Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations. **15 lectures**

**4. Quantum Statistics of Ideal Systems:** Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism.
**15 lectures**

**5. Fluctuations:** Thermodynamic fluctuations, random walk and Brownian motion, introduction to nonequilibrium processes, diffusion equation. **7 lectures**

Instructions for paper setters and candidates:
I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all including the Compulsory question.
III. All questions carry equal marks.

Books:

1. Statistical Mechanics (2nd edition): R.K. Pathria (Butterworth-Heinemann, Oxford).
2. Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi).
3. Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi).
4. Elementary Statistical Physics: C. Kittel (Wiley, New York).
5. Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi)
6. Statistical Physics by E S Rajagopal

**Paper MPH-104**

**SEMICONDUCTORS AND ELECTRONIC DEVICES**

**Max. Marks External Exam: 100 55 Hrs. (4L+1T Hrs./week)**

**1. Semiconductors and Junction diodes**

Introduction to semiconductors, Drift and diffusion of carriers, Fermi level, Direct and indirect semiconductors, Photoconductors, Capacitance of p-n junctions, Varactors, Tunnel diode, Light emitting diodes, Metal-semiconductor junctions; Ohmic and rectifying contacts, FET as switch and amplifier, MOSFET, Enhancement and depletion mode. Introduction to CMOS, CMOS Capabilities and Limitations and CMOS Transistors as logic gates (*viz*. NOT, NAND and NOR etc.)

**14 lectures**

**2. Circuit Analysis Theorems**

Sources of electrical power, Voltage and Current sources, equivalence between voltage and current source, Thevenin and Norton theorems, maximum power transfer theorem (statement and proof), Delta star (Y) transformations. **12 lectures**

**3. Operational Amplifier:** Operational amplifier, open loop op-amp, differential amplifier, inverting amplifier, non- inverting amplifier, voltage follower, difference and common mode gain, common mode rejection ratio. Input bias current, input offset current, input offset voltage, frequency response, slew rate, concept of feedback, Stability of operational amplifier.

Operational Amplifier as: Summing, integrator and differential, Logarithmic and anti-logarithmic amplifiers, Current-to-voltage and Voltage-to-current converter, Comparators; Schmitt trigger and square wave generator. Sinusoidal Oscillators: Phase Shift, Wein bridge.

**17 lectures**

**4. Switching circuits and Power electronics**

Construction and Working of Silicon controlled rectifier (SCR) Diac, Triac, Unijunction Transistor (UJT) and their applications, Transistor multivibrators: astable, monostable and bistable multivibrators.

**12 lectures**

**Instructions for paper setters and candidates:**

I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt FIVE questions in all including the Compulsory question.

III. All questions carry equal marks.

Books

1. Semiconductor Devices - Physics and Technology by S.M. Sze(Wiley)
2. Linear and Non-linear Circuits by Chua, Desoer and Kuh(Tata McGraw)
3. Integrated Electronics by Millman and Halkias(Tata McGraw Hill)
4. Electronic devices and Circuit theory by Boylestad and Nashelsky(Preutice Hall).
5. OPAMPS and Linear Integrateed circuits by Ramakant A Gayakwad (Prentice Hall).
6. Electronic Principles by A.P. Malvino(Tata McGraw, New Delhi).
7. Electronic Communication Systems : Kennedy and Davis (Tata McGraw Hill).
8. Semiconductor Physics by Maan Singh.
9. Semiconductor Physics by Choudhary
10. Principles of Electronics: V.K. Mehta and Shalu Mehta, S. Chand & Co. Ltd. New Delhi.

# PHYSICS LAB - I

**Course Code : MPH-105** **Max. Marks: 100**

***Objectives***: *The aim and objective of the courses on Physics Laboratory I is to expose the students of M.Sc. to the experimental techniques in general Physics, analog electronics, and semiconductor devices so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.*

***Note : Students are expected to perform at least 10 experiments in one semester.***

1. To trace I-V characteristic curves of diodes and transistors on a CRO, and learn their uses in electronic circuits.
2. Study of Zener regulator as voltage regulator.
3. To plot the input and output characteristics of CE configuration.
4. To Study the D C characteristics and applications of DIAC.
5. To study the D C characteristics and applications of SCR.
6. To study the D C characteristics and applications of TRIAC.
7. Investigation of the D C characteristics and applications of UJT.
8. Investigation of the D C characteristics of MOSFET.
9. Study of bi-stable, mono-stable and astable, multivibrators.
10. Study of Op-Amps and their applications such as an amplifier (inverting, non-inverting), scalar, summer, differentiator and integrator.
11. To determine the energy gap and resistivity of the semiconductor using four probe method.
12. To study temperature dependence of conductivity of a given semiconductor crystal using four-probe method and Vander Paw method.

## Paper MPH-106
## FUNDAMENTALS OF COMPUTER PROGRAMMING

**M. Marks External Exam: 100 33 Hrs. (1L+2P Hrs./week)**

**1. Introduction to Computers:** Chronological developments in computers, Computer systems, Hardware and Software; CPU, Primary memory, Secondary storage devices, Input devices, Output devices, Significance of software in computer system, Categories of software – system software, Application software, Compiler, Interpreter, Utility program, Binary arithmetic for integer and fractional numbers, Operating system and its significance.
**15 lectures**

**2. C/C++ Programming**: Introduction to algorithm, Flow charts, Problem solvingmethods, Need of programming languages. C character set, Identifiers and keywords, Data types, Declarations, Statement and symbolic constants, Input-output statements, Preprocessor commands, Operators, expressions and library functions, Control statements: Conditional, Unconditional, Bi-directional, Multi-directional and loop control structures, Functions, Arrays, Strings, Introduction to Pointers, Structure and union, Files.
**18 lectures**

**Recommended Books:**


1. Norton Peter, Introduction to Computers, Tata McGraw Hill (2005).
2. Kerninghan B.W. and Ritchie D.M., The C programming language, PHI (1989)
3. Kanetkar Yashawant, Let us C, BPB (2007).
4. Rajaraman V., Fundamentals of Computers, PHI (2004).

**Paper MPH-201**

**QUANTUM MECHANICS -I**

**Marks External Exam: 100** **55 Hrs. (4L+1T Hrs./week)**

- **Introduction to Wave Mechanics and Quantum Behaviour**

Wave equation and its general solution, Quantisation in wave mechanics and bound waves, the two-slit diffraction experiment, Particle/wave duality, The classical/quantum description of the state of a particle, the wave function and its interpretation, The cordinate and momentum representation of the quantum state, Fourier series and Fourier Transform, The wave equation in momentum space, The uncertainty principle. **13 lectures**

- **General Formalism of Quantum Theory**

The principle of superposition, Formation of wave-packet, Fourier analysis of wave-packet and its group velocity, Gaussian wave packet, probability current density, equation of continuity, Basic postulates of Quantum Mechanics, Probabilities in momentum and coordinate space, operator representation of dynamical variables, Hermitian operators and properties of eigenvalues and eigenfunctions of hermitian operators, expectation values and indeterminacies, Ehrenfest's theorem, Eigen value equation, Eigen value and eigen function,Ket Bra notation and Dirac delta function.

**14 lectures**

- **Schrödinger equation and its applications**

Hamiltonian operator andenergy eigenvalue equation, Time independent and time dependent schrodinger equation, particle in one dimensional box, the one dimensional simple harmonic oscillator, the hydrogen atom.

**8 lectures**

- **Angular Momentum in Quantum Mechanics**

Compatible and incompatible variables, commuting observables and simultaneous measurements, The angular momentum operators, commutation relations of angular momentum operators, Orbital angular momentum eigenfunctions and eigenvalues, the parity operator, The ladder operator method for the angular momentum spectrum, Electron spin, Pauli's spin matrices and their properties, Addition of two angular Momentna. **10 lectures**

5**. Matrix Formulation**

Alternative to Schrödinger's wave mechanics, the representation of the state of a particle in a discrete basis, the matrix representation for dynamical variables, eigenvalue equations in the matrix formulation, a spin half particle in a magnetic field.

**10 lectures**

**Instructions for paper setters and candidates**:

I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt FIVE questions in all including the Compulsory question.

- All questions carry equal marks.

**Suggested Books**

1 E. Merzbacher, Quantum Mechanics
2 R.P. Feynman, Feynman Lectures on Physics
3 Sara M. McMurry, Quantum Mechanics
4 L.I. Schiff, QuantumMechanics
5 J J. Sakurai,Modern Quantum Mechanics

**MPH-202**

**Condensed Matter Physics-1**

**Max. Marks External Exam: 100** **55 Hrs. (4L+1T Hrs. /week)**

**1. Crystal Structure**

Crystals, Bravais lattice, symmetry operations and classification of Bravais lattices, Common crystal structures, Determination of crystal structure: X-ray diffraction, Bragg's law, qualitative idea of electron and neutron diffraction. Elastic strain and stress component. Elastic compliance and stiffness constants. Elastic constants of cubic crystals. Elastic waves in cubic crystals. **12 lectures**

**2. Thermal properties of Crystal lattices**

Specific heat, lattices heat capacity, classical, Einstein and Debye theories of specific heat, Born's modification of the Debye theory, Thermal expansion. **12 lectures**

**3. Free Electron Theory of metals**

Free electron gas model, Electrical conductivity of metals, Drift velocity and relaxation time, the Boltzmann transport equation. Drude and Lorentz theory, The Sommerfeld theory of conductivity, thermal conductivity, Widemann-Franz law, Hall effect. **12 lectures**

**4. Magnetism**

Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, classical theory of Para magnetism, Quantum theory of Para magnetism, Quenching of orbital angular momentum, cooling by adiabatic demagnetization. Paramagnetic susceptibility of conduction electrons, Ferromagnetism, the Weiss molecular field, the interaction of the Weiss field, Ferromagnetic domains, Antiferro, Ferrimagnetism: The two sub lattice model, exchange interaction, Neel's theory of ferrimagnetisms

Superconductivity: Critical field, Meissner effect, Types of superconductors, specific heat, London equations, penetration depth, BCS Theory, Tunneling phenomena, Josephson effect, Introduction to high temperature superconductors. **19 lectures**

**Instructions for paper setters and candidates:**

*I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.*

*II. The students are required to attempt FIVE questions in all including the Compulsory question.*

*III. All questions carry equal marks.*

**Recommended Books:**


1. *C. Kittel, Introduction to Solid State Physics.*
2. *N.W. Ashcroft and N.D. Mermin, Solid State Physics.*
3. *J.M. Ziman, Principles of the Theory of Solids.*
4. *A.J. Dekker, Solid State Physics.*
5. *G. Burns, Solid State Physics.*
6. *M.P. Marder, Condensed Matter Physics.*
7. *B. D. Cullity, Elements of X-Ray Diffraction*
8. *L V Azaroff, Introduction to Solids R*
9. *R. L Sighal, Solid State Physics*

**MPH-203**

**ATOMIC & MOLECULAR PHYSICS**

**M. Marks External Exam: 100 55 Hrs. (4L+1T Hrs./week)**

**1. One Electron Atom:** Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, Hyperfine structure. **10 lectures**

**2. Two valance Electron Atom:** Vector model for two valance electrons atom, LS coupling, Pauli exclusion principle,Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling. **10 lectures**

**3. Atom in Magnetic Field:** Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field. **10 lectures**

**4. Atom in Electric Field:** Stark effect, First order Stark effect in hydrogen. **5 lectures**

**5. Molecular Spectroscopy:** Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions. **12 lectures**

**6. Spin Resonance Spectroscopy:** Electron spin resonance and nuclear magnetic resonance spectroscopy. **8 lectures**

**Instructions for paper setters and candidates:**

I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all including the Compulsory question.
III. All questions carry equal marks.

**Recommended Books:**

1. White H. E., Introduction to Atomic Spectra, McGraw Hill (1934).
2. Banwell C. N. and McCash E. M., Fundamentals of molecular spectroscopy , Tata McGraw Hill (1994).

**MPH - 204**
**Digital Electronics**

**M. Marks External Exam: 100** **55 Hrs. (4L+1T Hrs./week)**

**Unit I Number System and Binary Code:** Binary, Octal and Hexadecimal Number System (Conversion, Addition & Subtractions). Signed and unsigned numbers, Binary Subtractions using 1's and 2's compliment, ASCII code, Excess 3 code, Grey code, BCD code and BCD additions. Parity, Error Detection codes, Hammings Error correction code. **8 lectures**

**Unit II Minimization of logic function:** OR, AND,NOT,NOR,NAND,EX-OR, EX-NOR, Basic theorem of Boolean Algebra, Sum of Products and Product of Sums, canonical form, Minimization using K-map. **8 lectures**

**Unit III Logic Families:** RTL, DCTL, DTL, TTL, ECL, CMOS and its various types, Comparison of logic families. **8 lectures**

**Unit IV Combinational Circuits:** Combinational circuit design, Encoders, decoders, Adders, Sub tractors and Code converters. Parity checker, seven segment display, Magnitude comparators. Multiplexers, De-multiplexer, Implementation of Combinational circuit using MUX. **8 lectures**

**Unit V Sequential Circuits:** Introduction, flip flops, Clocked flip flops, SR, JK, D, T and edge triggered flip- flops. Excitation tables of Flip flops. Shift Registers, Type of Shift Registers, Counter, Counter types, counter design with state equation and state diagrams. **10 lectures**

**Unit VI Basic Cocepts of Integrated Circuits :** IC technology, fabrication of monolithic IC's epitaxial growth, diffusion of impurities, masking and etching, active and passive components, MSA, LSI and VLSI chips. **5 lectures**

**Unit VII Microprocessor :** Buffer registers, Bus organised computers, Microprocessor 8085 architecture, Assembly language programming : Instruction classification, addressing modes, timing diagram, Data transfer, Logic and Barch operations - programming examples. **8 lectures**

**Instructions for paper setters and candidates:**

I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi

II. The students are required to attempt FIVE questions in all including the Compulsory question.

III. All questions carry equal marks.

# Physics Lab - II

**Course Code : MPH-205** **Max. Marks: 100**

***Objectives***: *The aim and objective of the courses on Physics Laboratory II is to expose the students of M.Sc. to the experimental techniques in digital electronics, condensed matter physics and spectroscopy, so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.*

***Note : Students are expected to perform at least 10 experiments in one semester.***

1. To study the use of digital to analog and analog to digital converter.
2. To study logic gates and flip flop (JK, RS and D) circuits using on a bread-board. 14. 8085 microprocessor kit – familiarization and introductory programming.
3. Study of Logic Gates: Truth-table verification of OR, AND, NOT, XOR, NAND and NOR gates;
4. Realization of OR, AND, NOT and XOR functions using universal gates.
5. Realization Half Adder / Full Adder using Logic gates.
6. Realization Half Subtractor / Full Subtractor using Logic gates
7. Design 4-Bit Binary-to-Gray & Gray-to-Binary Code Converter.
8. Design 4-Bit magnitude comparator using logic gates.Multiplexer: Truth-table verification and realization of Half adder and Full adder using MUX.
9. Demultiplexer: Truth-table verification and realization of Half subtractor and Full subtractor using DEMUX.
10. Flip Flops: Truth-table verification of RS, JK , D, JK Master Slave Flip Flops.12
11. Design MOD-7 Synchronous up-counter using JK/RS/D Flip Flops.
12. Shift Register: Study of shift right, SIPO, SISO, PIPO, PISO & Shift left operations using IC7495 chip.
13. The Hall coefficient for given semiconductor and study its temperature dependence. 14. To study the FM and PM transition in Ni through electrical resistivity measurements.
15. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
16. Detrmination of crystal structure and lattice parameters using X-ray diffraction technique.
18. To determine the magnetic susceptibility of a material using Quink's method.
19. To find the wavelength of monochromatic light using Febry Perot interferometer.
20. To find the wavelength of sodium light using Michelson interferometer.
22. To find the grating element of the given grating using He-Ne laser light.
24. To verify the existance of Bohr's energy levels with Frank-Hertz experiment.
25. To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect.
26. To determine the g-factor using ESR spectrometer.

**Paper MPH-206**
**Computational Numerical Analysis**
Marks External Exam: 100 66 Hrs. (2L+4P Hrs./week)

1. **Numerical Algebraic and Transcendental Equations**:
Methods for determination of zeroes of linear and nonlinear algebraic and transcendental equations, Convergence of solutions, Solution of simultaneous linear equations, Evaluation of numerical determinants, Gaussian elimination and pivoting, Matrix inversion, Iterative methods.
**5 lectures**

**2. Interpolation and Approximation**
Introduction to interpolation, Lagrange approximation, Newton polynomials, Curve fitting by least squares, Polynomial least squares and cubic splines fitting. **4 lectures**

**3. Numerical Differentiation and Integration**
Numerical differentiation, Quadrature, Simpson's rule, Gauss's quadrature formula,Newton – Cotes formula. 4**lectures**

**4. Random Variables and Monte Carlo Methods**
Random numbers, Pseudo-random numbers, random number generators, Monte Carlo integration: Area of circle, Moment of inertia, Monte Carlo Simulations: Buffen's needle experiment, Random walk, Importance sampling. **5 lectures**

**5. Differential Equations**
Euler's method, Runge Kutta methods, Predictor-corrector methods, Finite difference method, Finite difference equations for partial differential equations and their solution
**4 lectures**

**6. Laboratory Assignments** (Do any Eight from the list below)

1. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. To solve Kepler equation by Newton-Raphson method,
3. Van der Wall gas equation for volume of a real gas by the method of successive approximation.
4. Interpolate a real data set from an experiment using the Lagrange's method.
5. Newton's method of forward differences and cubic splines.
6. Fit the Einstein's photoelectric equation to a realistic data set and hence calculate Plank's constant.
7. Estimate the value of $\pi$ by rectangular method,
8. Find the area of a unit circle by Monte Carlo integration.
9. To simulate Buffen's needle experiment.
10. To simulate the random walk.
11. To study the motion of an artificial satellite by solving the Newton's equation for its orbit using Euler method.
12. Study the growth and decay of current in RL circuit containing (a) DC source and (b) AC using Runge Kutta method. Draw graphs between current and time in each case.
13. Study the motion of two coupled harmonic oscillators. Compare the numerical

# Quantum Mechanics II

**Subject Code: MPH-301**

**Maximum External Marks:100** **55Hrs (4L+1T/week)**

1. **Perturbation Theory** Time-independent perturbation theory, First order perturbations, Second order perturbations: anharmonic oscillator, Degenerate perturbation theory: spin-orbit coupling, the time dependent Schrodinger equatio, Resonant transition between two energy states, Time dependent perturbation theory, Transition rates and Fermi golden rule

2. **Relativistic Quantum Mechanics**
Basic notions of relativity and the Lorentz transformations, Klein Gordon equation, Lorentz transformation of spinors and the Dirac equation, The Dirac equation in the presence of an electromagnetic field and the magnetic moment

3. **Elements of Scattering Theory**
Elastic scattering : elementary considerations on quantum theory of scattering in a given potential method of partial waves, the optical theorem, Born approximation, Low energy scattering and bound states, Scattering in a Coulomb field, scattering of identical particles and scattering of particles with spin, A brief overview of time dependent formulation of scattering. Inelastic collisions and the S matrix : a brief overview

4. **Systems of Identical Particles** Classical vs. quantum descriptions, Brief introduction to identical particles in quantum mechanics, Permutation operators and manybody wavefunctions, Application to 2 -electron systems, Pauli exclusionprinciple, Bose Einstein and Fermi Dirac Statistics.

## Recommended Books :


1. Modern Quantum Mechnics: J.J. Sakurai-Pearson Educaton Pvt. Ltd., New Delhi, 2002.
2. Quantum Mechanics: L I Schiff-Tokyo Mc Graw Hill, 1968.
3. Feynmann lectures in Physics Vol. III-Addison Wesly, 1975.
4. Quantum Mechanics: Powel and Craseman-Narosa Pub. New Delhi, 1961.
5. Quantum Mechanics: Merzbacher-JohnWiley & Sons, New York, 197

**MPH-302**

**Condensed Matter Physics-II**

**Max. Marks External Exam: 100** **55 Hrs. (4L+1T Hrs. /week)**

**1. Defects and Diffusion in Solids:**

Point defects: Impurities, Vacancies- Schottky and Frankel vacancies, Color centers, F-centres, Line defects (dislocations), Edge and screw dislocations, Berger Vector, Slip, Planar (stacking) Faults, Grain boundaries, Low angle grain boundaries, the Hydration energy of ions, Activation energy for formation of defects in ionic crystals, Diffusion in solids, Classification of diffusion process, Ficks law, Factor affecting diffusion and applications, Kirkendal law interpretation of diffusion in alkali halides. **15 lectures**

**2. Dielectric Properties of Solids**

Dielectrics and Ferroelectrics: Macroscopic field, The local field, Lorentz field. The Claussius-Mossotti relations, different contribution to polarization: dipolar, electronic and ionic polarisabilities, General properties of ferroelectric materials. The dipole theory of ferroelectricity, objection against dipole theory, thermodynamics of ferroelectric transitions. **15 lectures**

**3. Plasmas, Polaritons and Optical Properties:**

Dielectric function of the electrons gas, plasma optics, transverse and longitudinal modes in plasma, Electrostatic screening, polaritons and LST relations, Electron- phonon interaction, polarons, excitons, optical properties of metals and insulators, Kramer-Kroning relation. Liquid Crystals: Introduction, types, physical properties and applications. **15 lectures**

**4. Photoconductivity and Luminescene**

Photoconductivity, influence of traps, excitation and emission, Efficiency of a phosphor, Decay mechanisms, Thermoluminescence and glow curves, Thallium- activated alkali halides, The sulphide phosphors, Electroluminescence. **10 lectures**

**Instructions for paper setters and candidates:**

*I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.*
*II. The students are required to attempt FIVE questions in all including the Compulsory question.*
*III. All questions carry equal marks.*

**Recommended Books:**


*1. C. Kittel, Introduction to Solid State Physics.*
*2. N.W. Ashcroft and N.D. Mermin, Solid State Physics.*
*3. J.M. Ziman, Principles of the Theory of Solids.*
*4. A.J. Dekker, Solid State Physics.*
*5. G. Burns, Solid State Physics.*
*6. M.P. Marder, Condensed Matter Physics.*
*7. B. D. Cullity, Elements of X-Ray Diffraction*
*8. L V Azaroff, Introduction to Solids*
*9. R.L. Singhal, Solid State Physics,*

**Paper MPH-303**
**NUCLEAR & PARTICLE PHYSICS**

**M. Marks External Exam: 100** **55 Hrs.(4L+1T Hrs./week)**

**I. Properties of Atomic Nucleus**

Theories of nuclear composition (proton-electron, proton-neutron), Binding Energy, Semi-empirical Mass Formula for nuclear stability, Quantum numbers of nucleons, Quantum properties of nuclear states, nuclear angular momentum, Nuclear Magnetic dipole moment, Electric quadrupole moment, potential well, quantum statistics

**Lectures 10**

**II. Nuclear Interactions**

Nuclear Forces: Two nuclear system, deuteron problem, proton-proton and proton-neutron scattering experiments at low energy, meson theory of nuclear forces, e.g. Bartlett, Heisenberg, Majorans forces and potentials, exchanges forces and tensor forces, effective range theory-spin dependence of nuclear forces-Charge independence and charge symmetry of nuclear forces-Isospin formalisim- Yukawa interaction.

**Lectures 15**

**III Nuclear Models**

Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic-Applications of Shell model like Angular momenta and parities of nuclear ground states, Quantitative discussion and estimates of transition rates-magnetic moments and Schmidt lines, Collective model, Nuclear vibrations spectra and rotational spectra, applications,

**Lectures 15**

**IV Nuclear Reactions**

Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, Compound nucleus, scattering matrix, Reciprocity theorem, Breit Winger one level formula, Resonance scattering.

**Lectures 10**

**V Elementary Particle Physics**

Types of interaction between elementary particles- Hadrons and Leptons- Symmetry and conservative laws- Elementary ideas of CP and CPT invariance—Classification of Hadrons—Gell-Mann- Okubo mass formula for octet and decuplet hadrons—Charm, bottom and top quarks.

**Lectures 5**

**Instructions for paper setters and candidates:**

I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all including the Compulsory question.
III. All questions carry equal marks.

**BOOKS**

1. Roy R.R. & Nigam B.P., Nuclear Physics, New Age International Ltd (2001).
2. Preston M. A. and Bhaduri R. K., Structure of Nucleus Addision-Welsey (2000).
3. Pal, M.K., Theory of Nuclear Structure, East-West Press Delhi (1983).
4. Kaplan Irving Nuclear Physics, Narosa Publishing House (2000).
5. Tayal D. C., Nuclear Physics, Himalaya Publication home (2007)
6. Perkins D.H., Introduction to High Energy Physics, Cambridge University Press (2000).
7. Hughes I.S., Elementary Particles, Cambridge University Press (1991).
8. Close F.E., Introduction to Quarks and Partons, Academic Press (1979).
9. Segre E., Nuclei and Particles, Benjamin-Cummings Pub. Co. (1997).
10. Khanna M.P., Introduction to Particle Physics, Prentice Hall of India Pvt. Ltd (2004).

# MPH-304
# Classical Electrodynamics

**M. Marks External Exam: 100** **55 Hrs. (4L+1T Hrs./week)**

**1. Boundary Value Problems:** Uniqueness Theorem, Dirichlet or Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic & Magnetostatic Boundary value problem, Method of images with examples. **11 lectures**

**2. Time Varying Fields and Maxwell Equations:** Faraday's Law of induction, Displacement current, Maxwell equations, scalar and vector potentials, Gauge transformation, Lorentz and Coulomb gauges, General Expression for the electromagnetic fields energy, Poynting's Theorem. **10 lectures**

**3. Electromagnetic Waves:** Wave equation, Plane waves in free space and isotropic dielectrics, Polarization, Energy transmitted by a plane wave, Waves in conducting media, Skin depth. Reflection and Refraction of electromagnetic waves at plane surface between dielectrics, Fresnel's amplitude relations. Reflection and transmission coefficients, Polarization by reflection and total internal reflection. **14 lectures**

**4. Wave Guides:** Field at the surface of and within the conductor, Wave guides, TE, TM and TEM waves, Energy flow and attenuation in wave guides, Cavity resonators, Power loss in cavity and quality factor. **10 lectures**

**5. Radiation Systems: F**ields of radiation of a localized oscillating source, Electric & Magnetic dipole fields and electric quadrupole fields, Centre fed linear antenna, Introduction to radiation damping and radiation reaction. **10 lectures**

## Instructions for paper setters and candidates:

*I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.*
*II. The students are required to attempt FIVE questions in all including the Compulsory question.*
*III. All questions carry equal marks.*

## Recommended Books:


- Jordan E. C. and Balmain K. G., Electromagnetic Wave and radiating systems, Prentice Hall India Ltd. (1997).
- Griffiths D.J., Introduction to Electrodynamics, Prentice Hall (1998).
- Jackson J.D., Classical Electrodynamics, Wiley Eastern (1999)
- Puri S.P., Classical Electrodynamics, Tata McGraw Hill (1999).

## PHYSICS LAB - III

**Course Code : MPH-305** **Max. Marks: 100**

***Objectives***: *The aim and objective of the courses on Physics Laboratory II is to expose the students of M.Sc. to the experimental techniques in condensed matter physics and nuclear physics, so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.*

***Note : Students are expected to perform at least 10 experiments in one semester.***

1. To study the series and parallel characteristics of a photovoltaic cell.
2. To study the spectral characteristics of a photovoltaic cell.
3. Verification of Curie-Wiess law by studying temperature dependence of electrical susceptibility of a ferroelectric material.
4. Study of Thermoluminescence of f-centres in Alkali Halide Crystals.
5. To determine crystal structure of different material using x-ray diffraction.
6. To measure dielectric constant of Barium titanate as function of temperature and frequency and hence study its transition.
7. To measure heat capacity of solid at high and low temperatures.
8. To determine the dead time of given G. M Counter.
9. To study the statistical fluctuations of background counts in a G. M. Counter.
10. To determine the absorption coefficient of Pb and Fe for gamma rays using G. M. Counter.
11. To determine the energy of a pure beta-emitter using G.M. Counter and Al absorbers.
12. To study the energy resolution of $Cs_{137}$.
13. To identify the unknown gamma source using energy calibration.
14. To study time regulation of gamma – ray coincidence set-up
15. To study anisotropy of gamma-ray for $_{60}Co$ using coincidence set-up
16. To study energy resolution and calibration of a gamma-ray spectrometer using multichannel analyzer.
17. To study time resolution and calibration of a coincidence set-up using a multi-channel analyzer.

# MPH-401
# Physics Of Nano Materials

**M. Marks External Exam: 100** **55 Hrs. (4L+1T Hrs./week)**

**Introductory Aspects:** Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state in bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials. **11 lectures**

**Quantum Dots:** Electron confinement in infinitely deep square well, Confinement in one and two-dimensional wells, Idea of quantum well structure, quantum dots – single and interacting quantum dots, self organized quantum dots. **11 lectures**

**Preparation of Nanomaterials:** Bottom up: Cluster beam evaporation, Ion beam deposition, Chemical bath deposition; Top down: Ball Milling, Lithography. **11 lectures**

**Some Nanomaterials:** Properties and applications of Carbon nanotubes and nano fibres, Nanosized metal particles, Nanostructured polymers, Nano structured films and Nano structured semiconductors. **11 lectures**

**General Characterization Techniques:** Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, Raman and FTIR spectroscopy of nanomaterials. **11 lectures**

**Instructions for paper setters and candidates:**

*I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.*
*II. The students are required to attempt FIVE questions in all including the Compulsory question.*
*III. All questions carry equal marks.*

**Recommended Books:**


- Chow G-M & Gonsalves K.E., Nanotechnology - Molecularly Designed Materials, American Chemical Society.
- Jain K.P., Physics of Semiconductor Nanostructures, Narosa Publishing House (1997).
- Cao, G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Emperial College Press (2004).

**MPH-402**
**Synthesis and Characterization of Materials**

**Max. Marks External Exam: 100** **55 Hrs. (4L+1T/week)**

**1. Synthesis of Materials:** Bulk Synthesis: Solid state reaction method, sol gel method, chemical precipitation method. Film deposition method: Physical vapor deposition, Chemical vapor deposition, Spray pyrolysis, Sputtering (RF, DC); Pulsed laser deposition (PLD), Spin coating technique.
**12 lectures**

**2. Microscopic Techniques:** Transmission electron microscopy (TEM), Scanning electron microscopy (SEM); scanning tunneling microscopy (STM); Atomic force microscopy (AFM).
**10 lectures**

**3. Spectroscopic Techniques:** Diffraction techniques: X-ray diffraction, data manipulation of diffracted X-rays for structure determination; X-ray fluorescence spectrometry for element detection with concentration; Auger electron spectroscopy (AES), X-ray photoelectron spectroscopy (XPS). FTIR, UV-Visible spectroscop
**17 lectures**

**4. Low temperature techniques:** Measurement of Pressure.Production of Vacuum, Mechanical pumps, Diffusion pump, Getter and Ion pumps, Cryopumps, Closed Cycle Refrigerators, Single and Double Cycle He3 refrigerator, He4 refrigerator, He3-He4 dilution refrigerator, Thermoelectric coolers,Cryogenic thermometry.
**16 lectures**

**Instructions for paper setters and candidates:**
*I. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.*
*II. The students are required to attempt FIVE questions in all including the Compulsory question.*
*III. All questions carry equal marks.*

**Text and Reference Books:**

1. Thin Film Materials-Stress, defect, formation and surface evolution: L.B. Freund and S. Suresh- Cambridge,
2. Thin Film Phenomena :K.L. Chopra-Mc Graw Hill Book, Comp.,1979.
3. Thin Film fundamentals: A. Goswami-New age International, 2007
4. Material Science and Engg :W.D. Callister-John Wiley, 2001
5. Elements of X-ray Diffraction (3rd edition) : B.D. Cullity, S.R. Stock-Prentice Hall, 2001.
6. X-ray Fluorescence spectroscopy: R. Jenkins-Wiley Interscience, New York, 1999.
7. Methods of Surface Analysis : J.M. Walls- Cambridge University Press, 1989.
8. The principles and Practice of Electron Microscopy: Ian M. Watt-Cambridge University Press, 1997
9. Modern techniques for surface science: D.P. Woodruff and T.A. Delchar- Cambridge University Press, 1994.
10. Vaccum science and technology Paul A Redhead.
11. Dorothy Hoffman Handbook of Vacuum Science and Technology
12. James M. Lafferty Foundations of Vacuum Science and Technology (Foundations of Vacuum Science & Technology 1998