SYLLABUS

SEMESTER I

M1PHY01-CT01: Mathematical Methods in Physics

*(**Note**: At the beginning of the semester, students must be provided: Detailed Lecture schedule of topics to be covered in each lecture, tutorial topics, clearly defining chapters/sections of reference books followed, link to web resources etc. Examiners are expected to take into consideration the lecture schedule while setting the question papers to ensure questions are set within scope of the syllabus)*

External: 80 Marks Internal: 20 marks

Lectures: 40hrs Tutorials : 10 hrs

Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

Note: Candidates whose attendance is less than 75% will be awarded zero marks in the Internal

UNIT – I

Coordinate Systems: (4hrs)

Curvilinear coordinates, differential vector operations, special coordinate systems - rectangular Cartesian, spherical polar and circular cylindrical coordinates, and expressions of gradient, divergence, curl and Laplacian

Tensors: (4hrs)

Coordinate transformations, scalars, contravariant and covariant vectors, definition of contravarient, mixed and covariant tensor of second rank, Addition, subtraction and contraction of tensors, quotient rule

UNIT –II

Matrices: (4hrs)

Orthogonal matrices, Orthognality conditions- two and three dimensional cases, Hermitian and unitary matrices, Pauli matrices, Dirac matrices, Diagonalization of matrices - Eigen value and Eigen vectors

Elementary Group Theory: (4hrs)

Definition of group, Isomorphism and Homomorphism, Matrix representation- reducible and irreducible groups, subgroup-invariant subgroup, Discrete groups-two objects two-fold symmetry axis, three objects-three-fold symmetry axis, Continuous Groups- orthogonal group O_3^+, special unitary group SU(2)

UNIT – III

Second Order Differential Equations: (4hrs)

Separation of variables-ordinary differential equations, singular points, series solutions – Frobenius method and its limitations, Wronskian-linear independence and linear dependence

Special Functions: (4hrs)

Bessel functions of the first kind, integral representation, Legendre functions-generating function, recurrence relations and orthogonality, Associative Legendre functions, spherical harmonics, Hermite functions. Laguerre functions.

UNIT –IV

Complex Variables: (8hrs)

Functions of complex variable, Cauchy- Rieman conditions, Cauchy Integral theorem, Cauchy integral formula, Laurent expansion, Calculus of residues –poles, Essential singularities and branch points, Residue theorem, Jordan's lemma, Singularities on contours of integration, Evaluation of definite integrals.

UNIT –V

Fourier Series and Fourier Transforms: (4hrs)

Fourier series- General properties and uses, Differentiation and integration of Fourier series, Fourier transforms, Fourier integral-exponential form, Fourier transform-inversion theorem

Laplace Transform: (4hrs)

Elementary Laplace transforms, Laplace transform of derivatives**,** substitution properties of Laplace transform

Tutorials: (10hrs)

Applications of topics covered in each unit in Physics (based on problems given in the reference books) as given in the detailed lecture schedule will be covered in the tutorial classes.

Recommended Books:

Mathematical methods for Physicists – George B. Arfken & Hans J. Weber

Applied Mathematics for Physicists and Engineers – L. A. Pipes

M1PHY02-CT02: Classical Mechanics

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Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

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UNIT-I

Many particle systems; conservation laws, Constraints; their classification; degrees of freedom, D'Alembert's principle, generalized coordinates, Lagrange's equations from D'Alembert's principle, velocity dependent potentials and dissipative forces, Jacobi integral
(8 hours)

UNIT-II

Gauge invariance, generalized momenta, cyclic coordinates, integrals of motion, Symmetries of space and time with conservation laws (2L)

Rotating frames : transformation equations, pseudo (fictitious) forces, Rigid body dynamics: Angular momentum and Kinetic energy of motion about a point , Moment of intertia tensor,
(6 hours)

UNIT-III

Central force: definition and characteristics; properties, closure and stability of circular orbits, Two-body collisions, scattering in laboratory frame, scattering centre-of-mass frame (4 hours)

Variational principles: Techniques of the calculus of variations, Example of use of the variational principle to find the shortest distance between two points, Hamiltons principle: derivation of Lagrange's equations from Hamilton's principle, equations of motion. (4 hours)

UNIT-IV

Canonical transformation: generating functions, Hamilton-Jacobi equation; solution: Hamilton's principal function, Solution of harmonic oscillator problem by H-J method (4 hours)
Poisson brackets: fundamental PB, some properties, Poisson theorems, Angular momentum PBs, Invariance of PB under canonical transformations, relation of PB to quantum mechanics (4 hours)

UNIT-V

Types of equilibria, Periodic motion, small oscillations and normal modes, Free vibrations of a symmetric linear triatomic ,Special theory of relativity, Lorentz transformations, Velocity transformations, mass energy equivalence, Four vectors : velocity and acceleration 4 vectors. (8 hours)

TUTORIALS (10 T)

Principle of virtual work, problems related to conservation laws, Application of Lagrange eqns : Simple pendulum, two connected mass with string over pulley, rolling mass inside or outside a circular ring, Foucault's pendulum, examples of coriolis force on earth, Example of how energy can be conserved while H need not and vice versa

Infinitesimal contact transformation, Example of application of canonical transformation for a harmonic oscillator

In addition to the above problems, students are expected to solve examples and problems given in the text as assignments.

Reference Books:

Herbert Goldstein: Classical Mechanics
Rana and Joag, Classical Mechanics

M1PHY03-CT03: Quantum Mechanics-I

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UNIT-I

Inadequacy of Classical Mechanics: **3L**

Black body radiation, Planck' hypothesis, The photoelectric effect, Compton effect, Frank-Hertz experiment, Hamilton's principle. Schrödinger equation, Normalisation, probability interpretation of ψ, Admissible wave functions.

Linear Vectors Space: **5L**

Vectors: Definition and properties, Examples of linear vector spaces, norm of a vector, orthonormality and linear independence, Basis and dimensions, Completeness (Closure property), Hilbert space, subspace, Inequalities and Ehrenfest theorem.

Operators: Equality, product, sum, power, function, inverse of operators, eigenvalues and eigenvectors of an operator, Positive definite, continuous and bounded operators, Linear operators, Hermitian operators, Unitary operators, Projection operators.

UNIT-II

Dirac Space and Representation Theory: **3L**

Completeness of eigenfunctions, Bra and Ket notation for vectors, Dirac-Delta function, Matrix elements of change of basis, Unitary transformation. Representation theory, Coordinate and momentum representations.

Postulates of Quantum Mechanics & Uncertainty Relations: **5L**

Postulates of Quantum mechanics, Uncertainty relations**,** States with minimum uncertainty product, Commutators, Theorem of simultaneous eigenfunctions,

UNIT –III

Quantum Dynamics: **5L**

The equations of motion, Schrodinger picture, Heisenberg picture, Interaction Picture, Linear Harmonic Oscillator: Solutions from Schrodinger and Heisenberg Pictures, the method of second quantization

The Hydrogen Atom: **3L**

Two body equation, Separation of variables for spherically symmetric potential, Radial wave

equation, Radial wavefunctions and energy states.

UNIT –IV

Quantisation of Angular Momentum: **5L**

Definition, angular momentum of a system of particles, Matrix representation, Pauli matrices, the spin eigenvectors. Orbital angular momentum: Solutions, Spherical harmonics and properties, addition theorem (no proof).

Addition of angular momenta: **3L**

Clebsch-Gordan coefficients, the selection rules, properties of CG coefficients (without proof): symmetry, orthogonality and recursion relations.

UNIT –V

Perturbation Theory (Non-degenerate case): **5L**

Basic formulation of the method and applications: Anharmonic oscillator (x^4), linear harmonic oscillator, infinite square well.

Degenerate case: **3L**

Formulation and applications: Stark and Zeeman effects in H, Infinite cube well.

Textbook:

1. Quantum Mechanics, V.K. Thankappan, Wiley Eastern Ltd. (1986).**Reference books:**
1. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson Education Inc. (2005).
2. Principles of Quantum Mechanics, R. Shankar, Plenum Press, New York (1994).
3. Modern Quantum Mechanics, J.J. Sakurai, Addison and Wesley (1994).

M1PHY04-CT04: Electronics

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External: 80 Marks Internal: 20 marks

Lectures: 40hrs Tutorials : 10 hrs

Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

Note: Candidates whose attendance is less than 75% will be awarded zero marks in the Internal

UNIT-1

Amplification: Operational Amplifiers-I (8L)

Differential amplifier: circuit configurations, dual input, balanced output differential amplifier, DC analysis and AC analysis, inverting and non inverting inputs, Block diagram of typical OP-Amplifier, Constant current-bias level translator. Open loop configuration, inverting and non-inverting amplifiers, and Frequency- response.

OP-Amp Parameters: input offset voltage, bias currents, input offset current, output offset voltage, CMRR, frequency response, Slew rate. OP-Amp with negative feedback, voltage series feedback, effect of feed-back on closed loop gain, input and output resistance, band width.

UNIT-II

Operational Amplifiers based Instrumentations and their applications (3L):

DC and AC amplifier, voltage follower, Adder, subtractor, multiplier, phase changer, Active filters, Active Integrator and active differentiator.

Oscillators and wave shaping Circuits (5L)

Oscillator Principle - Oscillator types, Frequency stability response, the phase shift oscillator, Wien bridge oscillator, LC tunable oscillators, Multivibrators: Monostable and Astable, Comparators, Square and triangle wave form generators.

UNIT-III

Voltage regulators (3L)

Block diagram of Power supply, fixed voltage regulators, adjustable voltage regulators, switching regulators. Clipping and clamping circuits.

Boolean algebra and logic gates (4L): Canonical and standard forms, IC logic families, Simplification of Boolean functions: Karnaugh map of up to 4 variables, don't care conditions, NAND and NOR implementation

Combinational logic (4L)

Adders, subtractors, binary parallel adder, magnitude comparator, decoders/Demultiplexers encoders/multiplexers.

UNIT-IV

Sequential Logic (5L): Basic flip-flop, clocked RS flip-flop, T flip-flop, D flip-flop, J-K flip flop, triggering of flip-flops, JK master slave flip-flops; Synchronous and asynchronous counters: Binary counters, Decade counters, Registers

Microprocessors (3L):

Organization of a Micro computer based system, Microprocessor architecture and its operations, Memory, memory map. The 8085 microprocessor unit; Functional block diagram.

UNIT-V

Assembly Language Programming of 8085 (8L): Instruction set of 8085: Data transfer operations, Arithmetic operations, Logic operations, Branch operations, Addressing modes of 8085 instructions, Assembly language programmes involving data transfer, arithmetic logic operations and looping, counting and indexing - counters and timing delays.

Tutorials (10T hrs)

Review of basic electronics: Currents in a transistor, Design of CE and CC Amplifier, Design of two stage amplifier. In addition to the above, problems from the reference books can be given as assignments to the students.

Reference Books:

1. Integrated Electronics, by J. Millman and C.C. Halkias, TMH, New Delhi
2. "OP-AMP and Linear Integrated Circuits" by Ramakanth, A. Gayakwad, PHI, New Delhi
3. "Electronic Devices and Circuit Theory" by Robert Boylestead and Louis Nashelsky, PHI, New Delhi – 110001
4. "Digital Logic and Computer design" by Electronics by Morris Mano
5. "Digital Principle and Applications" by A.P. Malvino and Donald P. Leach, TMH, New Delhi.
6. "Microprocessors Architecture, Programming and Applications with 8085/8086" Ramesh S Gaonkar, Wiley - Eastern Ltd.

M1PHY05-CP01 : General Physics Laboratory

NOTE:

1. Students are required to complete at least five experiments allotted to them.
2. Students are expected carry out the practical after understanding theoretical principle behind each experiment, design of experiments, working principle of the equipments/instruments, sources of errors in experiments etc.
3. Experimental errors must be estimated in all experiments.

LIST OF EXPERIMENTS

1. Measurement of arc spectra by constant deviation spectrometer.
2. Determination of elastic constants of glass by method of Cornu's fringes.
3. Determination of coefficient of thermal conductivity of metal by Angstrom's method.
4. To study variation in internal resistance of a material with temperature.
5. To study the Hall effect in a given semiconductor probe and to find the Hall Voltage and Hall Coefficient, Charge Carriers, Hall angle and Mobility.
6. To study the characteristic of given Solar Cell Panel.
7. Determination of λ, $d\lambda$, and thickness using Michelson's interferometer.
8. Determination of wavelength of light emitted by He-Ne laser and to verify the law governing Interference from a Young's double slit experiment.
9. (a) Measurement of wavelength of He-Ne laser light using ruler. (b) Measurements of thickness of thin wire with laser.
10. Investigation of Faraday's effect and to determine Verdt's constant.
11. To plot the polar curve of a filament lamp and to determine its mean spherical intensity.
12. To study the dissociation limit of iodine.
13. Jamin's Interferometer's method for refractive index of air using He-Ne Laser.
14. Beam characteristics of a He-Ne laser beam.
15. Any other experiments designed and setup by the teacher.

M1PHY06-CP02: Electronics Laboratory

Internal Assessment: ***20 %***

External Assessment: ***Section-A: 30%, Section-B: 30 %, Viva-Voce: 20%***

NOTE:

1 Students are required to complete at all experiments allotted to them from Section-A and section-B.

2. Students are expected carry out the practical after understanding theoretical principle behind each experiment, design of experiments, working principle of the equipments/instruments, sources of errors in experiments etc.

3. Experimental errors must be estimated in all experiments.

LIST OF EXPERIMENTS

SECTION-A: Analog Electronics

1. Measurement of operational amplifier parameters.
2. Study of Clipping and clamping circuits.
3. Study of active filter circuits
4. Study of active integrator and differentiator circuits
5. Study of Wien Bridge Oscillator
6. Study of wave form generators: (a) Square wave generator (astable multivibrator), (b) Pulse generator (monostable multivibrator) and triangular wave generator.
7. Study of Schmitt Trigger and comparators
8. Study of UJT parameters and Relaxation Oscillator
9. Design of a Regulated power supply: (a) Study of series voltage regulated power supply and (b) study of IC regulated power supply

SECTION-B: Digital Electronics

1. Study of Combinational circuits:
   - (i) Two bit and four bit adder
   - (ii) Subtractor
   - (iii) Decoder and 7- segment display
   - (iv) Multiplexer and
   - (v) Demultiplexer

2. Study of Sequential circuits:

   (i) Flips Flops : RS, JK, JKMS, D &T flip-slops

3. Study of Shift Registers

4. Study of Counters :

   (i) 4-bit Ripple counter

   (ii) 4-bit Synchronous Counter

   (iii) BCD Counter

Note: Any other experiments suggested by teacher

Reference Books:

1.“Integrated Electronics”, by J. Millman and C.C. Halkias, TMH, New Delhi

2."OP-AMP and Linear Integrated Circuits" by Ramakanth, A. Gayakwad, PHI, New Delhi

3."Electronic Devices and Circuit Theory" by Robert Boylestead and Louis Nashelsky, PHI, New Delhi - 110001, 1991.

4.“Digital Logic and Computer design” by Electronics by Morris Mano

5."Digital Principle and Applications" by A.P. Malvino and Donald P. Leach, TMH, New Delhi.

7. Lab manuals