## U.G. 1st Semester

## Paper: PHY101C (Core)
## Mathematical Physics I

**Credits: 5 = 4+1+0 (64 Lectures)**

**Theory: 64 Lectures**

**Calculus:** (20 lectures)

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular integral with operator method. Method of undetermined coefficients and variation method of parameters.

**Vector Differentiation:** (12 lectures)

Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

**Vector Integration:** (20 lectures)

Ordinary Integrals of Vectors. Multiple integrals. Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes theorems and their proof.

**Orthogonal Curvilinear Coordinates:** (10 lectures)

Orthogonal curvilinear coordinates. Derivation of gradient, divergence, curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems.

**Dirac Delta function:** (2 lectures)

Definition of Dirac delta function and simple examples.

**Recommended Books:**

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris,2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Schaum Series, Vector Analysis, Murray Speigel, Tata McGraw-Hill

## Paper: PHY102C (Core)
## Mechanics and Special Theory of Relativity

**Credits: 5=3+1+1 (48 Lectures)**

**Inertial Systems:** (3 Lectures)
Reference Frames :- Inertial Frames and Galilean Transformations. Galilean Invariance and Conservation Laws. Momentum of variable- mass system: motion of rocket.

**Non-Inertial Systems:** (5 Lectures)
Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

**Fundamentals of Dynamics:** (12 Lectures)
Dynamics of a System of Particles. Center of Mass. Calculation of center of mass of (i)non-uniform rod (ii)semicircular arc (iii)semicircular disc and (iii) solid hemisphere. Work and Energy Theorem : Work and Kinetic Energy Theorem. Conservative and Non- Conservative Forces. Potential Energy. Energy Diagram. Stable and Unstable Equilibrium. Elastic Potential Energy. Force as Gradient of Potential Energy. Work and Potential energy. Work done by Non conservative Forces. Law of Conservation of Energy. Elastic and Inelastic Collisions between particles. Center of Mass Frame and Laboratory Frames.

**Rotational Dynamics:** (10 Lectures)

Angular Momentum of a Particle and System of Particles. Torque. Conservation of Angular Momentum. Rotation about a Fixed Axis. Moment of Inertia. Calculation of Moment of Inertia for Rectangular, Cylindrical, and Spherical Bodies. Kinetic Energy of Rotation. Motion involving both Translation and Rotation. Compound Pendulum. **Elasticity :** Relation between elastic constants. Twisting torque on a Cylinder or Wire, Cantilevers. (light only)

**Gravitation and Central force Motion:** (8 Lectures)

Law of gravitation. Gravitational Potential and Field due to Spherical Shell and Solid Sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws.

**Special Theory of Relativity**: (10 Lectures)

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy & Momentum.

**Recommended Books:**

1. An introduction to mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)

2. Mechanics Berkeley physics course, v.1: By Charles Kittel,Walter Knight, Malvin Ruderman,Carl Helmholz,Burton Moyer, (Tata McGraw-Hill, 2007)

3. Mechanics by D S Mathur (S. Chand & Company Limited, 2000)

4. Mechanics by Keith R. Symon (Addison Wesley; 3 edition, 1971)

5. University Physics by F W Sears, M W Zemansky and H D Young (Narosa Publishing House,1982)

6. Feynman Lectures, Vol.I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education.

**7.** Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

**List of Experiments: Credit=1 (16 Classes of 2 hours each)**
1. To determine the Acceleration due to Gravity by a bar pendulum.
2. To determine the value of g using Kater's Pendulum.
3. To determine the Moment of Inertia of a regular body about an axis by torsional oscillation and determine the rigidity modulus of the suspension wire.
4. To study spring and determine spring constant, g and modulus of rigidity.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method.
6. To determine the Young's Modulus of a Wire by Optical Lever Method.

7. To determine the Modulus of Rigidity of a Wire by static torsion method.
8. To determine the Elastic Constants of a Wire by Searle's method.
9. To determine the surface tension of a liquid (water) by Jurin's method.
10. To determine Poisson's ratio of an indian rubber in the form of a tube.

***(At least five experiments to be performed )***

**Recommended Practical Books:**

1. B Sc Practical Physics, 1st Edn. (2007), Geeta Sanon, R. Chand & Co.
2. Advanced Practical Physics , B. L. Worsnop and H. T. Flint,, Asia Publishing House, New Delhi.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4 th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11 th Edn, 2011,Kitab Mahal.

## Paper: PHY103M (Modular General Elective)
## Fundamentals of Physics

**Credits: 4 = 3+1+0 (48 Lectures)**

**Theory: 48 Lectures**

Aim and Scope: This course, which should be accessible to students across disciplines, is aimed at giving them an overview of basic physics. The course will not be merely descriptive but will introduce the student to use of mathematics in the description of natural phenomena.

**UNIT 1: Mathematical background: (3 lectures )**

Quantities and units. Precision: significant figures. Graphs, equations and functions.

**UNIT 2: Motion: (5 lectures)**

Distance and displacement. Speed, velocity and and acceleration. Constant velocity.
Changing velocity: constant acceleration. Measuring change: slopes and derivatives.
Areas and integrals.

**UNIT 3: Forces and Newtonian Physics: (7 lectures)**

Newton's laws of motion: the first law and the second law. Units of force.
Combining forces: adding vectors, components of vectors. Friction.
Momentum and momentum conservation: action, reaction and Newton's third law.
Rotational motion: uniform circular motion, angular momentum and torque.

**UNIT 4: Energy and conservation of energy: (5 lectures)**

What is work? Energy of motion: kinetic energy. Energy of position: potential energy.
Mechanical energy. Conservation of energy. Power.

**UNIT 5: Electricity and Magnetism: (6 lectures)**

The electric force and electric field. Field lines and flux. Electric potential energy and electric potential.
The force between two parallel currents. The magnitude and direction of the magnetic field due to an electric current. Motion of a charge in a magnetic field.

**UNIT 6: Waves: Mechanical and Electromagnetic Waves: (8 lectures)**

Types of waves, Types of waves. Graphical and mathematical description.
Interference. Standing waves. Resonance.
Maxwell's contribution to electromagnetism. Propagating fields. The electromagnetic spectrum.

**UNIT:8: Our Universe and the cosmos: (Qualitative only) (8 Lectures)**

Scale: The hierarchy of size from atoms to galaxies. The four forces. Basic building blocks of matter. Energy. Atoms and the periodic table.
Early concepts about the universe, Copernican revolution, Discovery of different galaxies in the beginning of twentieth century, Hubble's discovery and its implication, Origin of the universe according to Big Bang model. Age of the universe and of our solar system. The sun in our galaxy Milky Way**.** Recent discoveries in our understanding of the makeup of the cosmos, including dark matter and dark energy.

**UNIT 9: Elements of modern Physics: (6 Lectures)**

Matter and radiation, Quantum idea, Wave particle duality, Heisenberg's uncertainty principle. Discussion (without derivation) about the results of special theory of relativity. Equivalence of mass and energy with simple numericals.
Fission and Fusion: Basic principle of a nuclear reactor, Energy generation inside sun .

**Recommended Books:**

1. *Principles of Physics* by J walker, D Halliday and R Resnick 8/e. 2008, Wiley

2. *Basic Physics- a self teaching guide* by Karl F Kuhn Jon Wiley and Sons 1979

3. *Conceptual Physics* Paul g Hewitt, Pearson Internet Edition, 2006