B.Sc. Multidisciplinary with Physics

1st Semester

Physics DSC-PHYT-111(a)**: MECHANICS**

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering whole syllabus from all the units), Section B from Unit 1, Section C from Unit II, Section D from Unit III and Section E from Unit IV. Examiner will set nine questions in all, question number 1 will be compulsory and two questions from each Unit, i.e., I, II, III and IV, respectively. Each question will carry 10 marks. Question Number 1 (Section A) will consist of seven sub-short answer type questions carrying 02 (two) marks each and candidate has to attempt any five (5) questions. Each Question must include at least 20% numerical problems.*
2. *Candidate will have to attempt five questions in all, i.e., selecting one question from each sections B, C, D & E.* From the *Compulsory section A candidate has to attempt any five (5) out of seven (7) questions. The duration of the examination will be 3 hours.*

Pre-requisite: Brief introduction to Newtons's Laws of motion and Newtons law of gravitation, Motion of a particle in uniform gravitational field; G (Gravitational constant) as a natural constant; Need of differntial equations; Differential equations in mechanics: Projectile motion, spring mass system (simple harmonic oscillator), simple pendulum, Newtons's second law of motion; First order homogeneous differential equations: Example (Cooling coffee problem); Second order differential equations with constant coefficients: Example (spring mass system (simple harmonic oscillator)).

Unit-I

Coordinate systems, Symmetries and conservation laws: Need of Coordinate system, Types of Coordinate systems: **Orthogonal coordinate systems** (Cartesian coordinate system (left handed and right handed system), plane polar coordinate system, spherical polar coordinate system and cylindrical coordinates) and **non-orthogonal coordinate system** (brief introduction with examples), Relation between cartesian and spherical polar coordinates in terms of position, velocity and acceleration, Area and volume elements in spherical polar coordinates, Concept of plane angle and solid angle. Symmetries and conservation laws: homogeneity of space and conservation of momentum, isotropy of space and conservation of angular momentum, homogeneity of time and conservation of energy **(7 Lectures)**

Frames of Reference: Inertial and accelerated (non-inertial) frames of reference: Earth and stars as a reference frame and other examples, Galilean transformations, Galilean invariance: distance, velocity, acceleration, Newton's second law, momentum and energy; Fictitious or pseudo force, Fictitious force in a rotating frame: Coriolis force and centrifugal force; Applications of Coriolis force & centrifugal force. Foucault's pendulum and its applications (Qualitative idea). (5) **Lectures)**

Unit-II

Inverse square law force: Classification of forces: central and non-central forces (examples), Inverse Square Law, Concept of centre of mass and reduced mass and their importance in central force problems,reduction of two body central force problem to equivalent one body problem. reduced mass of electron proton system and electron positron system. **(5 Lectures)**

Motion under a central force: Features of central force motion,Central force motion as a one body problem, Motion confined to a plane, conservation of angular momentum, conservation of energy; Energy equation and

energy diagrams; Equation of conic (ellipse, hyperbola and parabola), Keplers laws of planatery motion. **(6 Lectures)**

Unit-III

Fundamentals of Collisions: Basic Concepts of Collision, Reference Frames: Laboratory frame (Lab frame) and Center of Mass (CM) frame; Elastic Collisions in the Lab Frame: Kinematics of elastic collisions in one dimension (1D), Elastic Collisions in the CM Frame, Relationship between Lab and CM frame quantities, Relation between Kinetic Energies and Scattering Angle in Lab and CM frames **(7 Lectures)**

Applications of Collisions: Rutherford Scattering, Scattering: Angle and Impact Parameter, Collision Cross Section, Differential Scattering Cross Section. **(3 Lectures)**

Unit-IV

Special Theory of Relativity and Lorentz transformations: Ether Hypothesis, Michelson-Morley Experiment, Postulates of Special Theory of Relativity, Lorentz Transformation, Consequences of Lorentz Transformations: Length Contraction, Simultaneity of Events, Time dilation; Experimental Evidences for Time Dilation and Length Contraction, Twin paradox, Relativistic Addition of Velocities, Relativistic Doppler Effect. (**8Lectures)**

Relativistic Mechanics: Introduction,Variation of mass with velocity. mass-energy equivalence, relativistic momentum and energy, Lorentz transformation of momentum and energy. Lorentz transformation of forces, Minkowski space. **(4 Lectures)**

Reference Books:

1. Classical Mechanics by John R Taylor, University Science book ,U.S.
2. An Introduction to Mechanics, D. Kleppner, and R. Kolenkow, Tata McGraw Hill.
3. Mechanics: Berkeley Physics Course Vol 1, by Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz and Burton Moyer
4. Mechanics, D.S. Mathur, S. Chand and Company Ltd.
5. Classical Mechanics, J.C. Upadhyaya Himalaya Publishing House.
6. Concepts of Modern Physics: Special Indian Edition by Arthur Beiser
7. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
8. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
9. Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
10. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
11. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
12. Modern Physics, K. Krane, John Wiley and Sons.

Course Outcomes: B.Sc. (Discipline-Physics)		
Course Name	**Course Outcomes**	**Methodology**
Semester I		
Mechanics DSC-PHYT-111(a)/ MC-PHYT-111(a)	**CO1:** Grasp the fundamental principles of mechanics, role of coordinate systems, and symmetry and conservation laws of motion. **CO2:** Understand the concept of Inertial and non-inertial frames of references and analyze motion in different frames. **CO3:** Understand the description of Central Motion **CO4:** Learn the concept of particle collision (elastic and inelastic) in lab and CM frames **CO5:** Understand and apply the principles of special theory of relativity - special relativistic effects and their effects on the mass and energy of a moving object.	

1st Semester

DSC-PHYP-111(b): **Mechanics Laboratory**

Note:

1. ***Teacher should give a lecture on error analysis before practical classes.***
2. ***A student has to perform minimum ten (10) experiments.***
3. ***Error analysis should be done in each experiment.***
4. ***External examiner for the end semester practical exam should be deputed by the H. P. University and should not be from the same college. University has to depute from any other college affiliated to the University.***

List of Experiments:

1. Measurements of length/diameter using Vernier Caliper, Screw Gauge and Travelling Microscope.
2. To measure the density and identify the material of a given wire using Screw Gauge.
3. To find the radius of curvature of spherical surfaces using spherometer.
4. To determine the Height of anaccessible and inaccessible object using a Sextant.
5. To determine the Moment of Inertia of a Flywheel.
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 Maxwell's Needle.
8. To determine the Elastic Constants of a Wire by Searle's method.
9. To determine acceleration due to gravity by Bar Pendulum.
10. To determine acceleration due to gravity by Kater's Pendulum.
11. To determine acceleration due to gravity and velocity for a freely falling body using Digital Timing Technique.
12. To study the Motion of a Spring and calculate (a) Spring Constant and (b) Value of acceleration due to gravity.
13. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
14. To compare the moment of inertia of a solid sphere and hollow sphere or solid disc of same mass with the torsional pendulum.
15. To verify (a) the law of conservation of linear momentum and (b) law conservation of kinetic energy in case of one and two dimension elastic collision,.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick 2015, Cengage Learning India Pvt. Ltd.
4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
5. B.Sc. Practical Physics C.L. Arora, S. Chand and Company Ltd.