PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
*Autonomous*
Siddhartha Nagar, Vijayawada–520010
***Re-accredited at 'A+' by the NAAC***

**23PHMAL121: Mechanics and Properties of Matter** **Major 3(TH)**
Offered to: B.Sc. Honours (Physics) Semester – II
Max. Marks: 100 (CIA: 30+ SEE: 70) 60Hrs Credits: 03

## Course objectives

1. The primary objective of the Mechanics and Properties of Matter course is to furnish students with a comprehensive comprehension of the dynamics exhibited by physical systems.
2. This encompasses a thorough exploration of mechanical motion as well as an in-depth examination of the diverse properties inherent in different forms of matter.
3. The course seeks to establish a solid foundational knowledge that enables students to grasp the intricate interplay between the behavior of physical systems and the intrinsic characteristics defining the nature of matter.

**Course outcomes:** On successful completion of this course, the students will be able to:

**CO1** Recollect the fundamental principles of vectors, mechanics of particles, and mechanics of rigid bodies. PO1

**CO2** Fosters the development of a scientific mindset that includes questioning assumptions and seeking deeper understanding.PO1

**CO3** Utilize mathematical models to represent and solve problems related to real-world applications PO1

**CO4** Combine knowledge from various areas to analyze complex physical systems PO1

**CO5** By the end of the course, students will be able to critically evaluate and assess complex, multidisciplinary problems by integrating principles PO6

| CO-PO MATRIX | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **CO-PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** |
| 23PHMAL 121 | **CO1** | | | | | M | | |
| | **CO2** | | | | | | M | |
| | **CO3** | | | | | | M | |
| | **CO4** | | | | | | | M |
| | **CO5** | | | | | | M | |

| Unit | Learning Units | Lecture Hours |
|---|---|---|
| I Vectors | **A**) Scalar and vector fields, Gradient of a scalar field and its physical significance. Divergence and curl of a vector field with derivations and physical interpretation.<br>**B**) Vector integration (line, surface, and volume), Statement and proof of Gauss and Stokes theorems. | 12 |
| II Mechanics of particles | **A**) Review of Newton's Laws of Motion, Motion of variable mass system, Multistage rocket, Conservation of energy and momentum, Elastic collisions in one dimension, Elastic and oblique collisions in two dimensions.<br>**B**) Concept of Impact parameter, Cross section, Rutherford scattering-derivation. | 12 |
| III Mechanics of rigid bodies and continuous media | **A**) Rigid body, rotational kinematic relations, equation of motion for a rotating body, Angular momentum and Inertial Tensor, Euler equations, Precession of a top, Precession of the equinoxes.<br>**B**) Elasticity, Stress and strain, Hooke's law, Elastic constants of isotropic solids and their relations, Poisson's ratio, and expression for Poisson's ratio. | 12 |
| IV Central forces | **A**) Central forces - definition and examples, characteristics of central forces, conservative nature of central forces, conservative force as a negative gradient of potential energy.<br>**B**) Equations of motion under a central force, Derivation of Kepler's I, II, & III laws, Motion of satellites – escape velocity and orbital velocity. | 12 |
| v Special Theory of Relativity | **A**) Galilean relativity, Absolute frames. Michelson-Morley experiment - the negative result. Postulates of the special theory of relativity.<br>**B**) Lorentz transformation and its applications (i) time dilation (ii) length contraction (iii) mass-energy relation. | 12 |

**TEXTBOOKS**

1. B. Sc. Physics, Vol.1, Telugu Academy, Hyderabad

**Reference Books**

1. Mechanics - D.S. Mathur, Sulthan Chand & Co, New Delhi
2. Mechanics - J.C. Upadhyaya, Ramprasad & Co., Agra
3. Properties of Matter - D.S. Mathur, S.Chand & Co, New Delhi ,11th Edn., 2000

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**Model Question Paper**

**23PHMAL121: Mechanics, Waves and Oscillations**

**MAX.MARKS : 70** **MAX.TIME: 3Hrs**

**SECTION-A**

Answer the following: 5 x 10 = 50 M

1. A) Define the divergence of a vector field. Derive an expression for the divergence of a vector field (L3. CO3)

(OR)

B) State and prove Gauss divergence theorem (L3, CO3)

2. A) Define a system of variable mass. Explain the motion of the rocket, Derive an expression for the velocity of the rocket at any time. (L3, CO3)

(OR)

B) Discuss the Rutherford scattering and derive an expression for the scattering angle. (L3, CO3)

3 A) What is processional motion? Find the angular velocity of the precession of a spinning top. (L3, CO3).

(OR)

B) Define the three elastic constants y, η, and k. Derive the relation between them. (L3, CO3)

4. A) What is conservative force? Show that central forces are conservative. (L3, CO4).

(OR)

B) State Kepler's third law of motion. And prove that the square of the period of revolution of a planet moving in a circular orbit around the sun is proportional to the cube of its distance from the sun. (L3, CO4)

5 A) Describe the Michelson-Morley experiment and explain the physical significance of negative results. (L3, CO4)

(OR)

B) State the fundamental postulates of the special theory of relativity and deduce the Lorentz transformations. (L3, CO4)

## SECTION-B

Answer the following questions: 3x4=12M

6. A) Explain the gradient scalar field and give its physical significance (L2, CO1)

(OR)

B) State Newton's laws of motion and give two examples each. (L1, CO2)

7. Write a short note of precession of the equinoxes (L2, CO3)

(OR)

Explain central forces with examples. (L1, CO4)

8. A) Explain time dilation. (L1, CO5)

(OR)

B) Explain central forces with examples. (L1, CO4)

## Section – C 2X4=8M

Answer the following:

9. A) If $\vec{A} = xy\hat{i} - 2x^2y\hat{j} + 2yz\hat{k}$ then find curl $\vec{A}$ at (1,1,0) (L4, CO1)

(OR)

B) A rocket burns 0.1 kg of fuel per second. If the force exerted by ejecting gases on the rocket is 200N, find the exhaust velocity of gases. (L4, CO3)

10. A) If the Earth is one-half of its present distance from the sun, what will be the number of days in a year (L3, CO4)

(OR)

B) If the total energy of a particle in motion is exactly thrice its rest energy, what is the velocity of the particle? (L3, CO5)

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