

Code No: **R231210**

**R23**

**SET - 1**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA VIZIANAGARAM**  
**I B. Tech II Semester Supplementary Examinations January-2025**  
**ENGINEERING MECHANICS**

(Common to CE, MECH and AME)

Time: 3 hours

Max. Marks: 70

*Question paper consists of Part A & Part B.*  
*Part A is compulsory, Answer all questions.*  
*In Part B, Answer any one question from each unit.*

\*\*\*\*\*

**PART-A**

**(20 Marks)**

- 1 a) State the conditions of equilibrium for a system of coplanar concurrent forces. [2]
- b) What is limiting friction, and when does impending motion occur? [2]
- c) State Lami's theorem and mention one condition where it is applicable. [2]
- d) State the Triangle Law of Forces and its converse condition for equilibrium. [2]
- e) A uniform solid cone has a base radius  $R$ , height  $H$ , and density  $\rho$ . What is the vertical distance of its center of gravity from the base. [2]
- f) Write the transfer formula for the product of inertia and explain its components. [2]
- g) A car accelerates uniformly from rest and reaches a velocity of 20 m/s, in 10 seconds. Calculate the acceleration and the distance travelled by the car during this time. [2]
- h) State D'Alembert's principle and explain its significance in dynamics. [2]
- i) State the principle of work and energy for a particle in motion. [2]
- j) Define the difference between displacement and velocity in the context of rectilinear motion. [2]

**PART-B**

**(50 Marks)**

**Unit-1**

- 2 a) Define the principles of transmissibility and superposition of forces. Explain their significance in engineering mechanics with suitable examples. [5]
- b) Derive the expression for the angle of repose and explain its relationship with the coefficient of friction. [5]

(OR)

- 3 a) A particle is acted upon by three forces:  $F_1 = 10 \text{ N}$  at  $0^\circ$ ,  $F_2 = 15 \text{ N}$  at  $120^\circ$ , and  $F_3 = 20 \text{ N}$  at  $240^\circ$ . Determine the resultant force and its direction. [5]
- b) Describe the significance of the parallelogram law of forces. Two forces of magnitudes  $40 \text{ N}$  and  $60 \text{ N}$  act at a point with an angle of  $120^\circ$  between them. Determine the resultant force and its direction. [5]

### Unit-2

- 4 a) Draw the free body diagram for a uniform ladder of length  $L$  and weight  $W$ , leaning against a smooth vertical wall and resting on a rough horizontal surface. The angle between the ladder and the horizontal is  $\theta$ . Identify all forces acting on the ladder. [5]
- b) Explain the graphical method to check the equilibrium of a coplanar system of forces using a force polygon. [5]

(OR)

- 5 a) A light rod  $AB$  of length  $5 \text{ m}$  is hinged at  $A$  and held in equilibrium by a string attached at  $B$ . A force of  $100 \text{ N}$  acts vertically downward at a point  $2 \text{ m}$  from  $A$ . The string makes an angle of  $30^\circ$  with the horizontal. Using Lami's theorem, find the tension in the string. [5]
- b) A uniform beam of weight  $W=200 \text{ N}$  is supported at two points  $A$  and  $B$ . A load of  $P=100 \text{ N}$  is applied at a point between the supports. Show using the principle of virtual work that the reactions at  $A$  and  $B$  are consistent with equilibrium. [5]

### Unit-3

- 6 a) A composite figure consists of a rectangle of dimensions  $4 \text{ m} \times 2 \text{ m}$  and a semicircle of radius  $1 \text{ m}$  placed on top. Determine the centroid of the composite figure from the base of the rectangle. [5]
- b) State and derive the Transfer Theorem for moments of inertia. [5]

(OR)

- 7 a) Use Pappus's second theorem to find the surface area of a sphere of radius  $r$ . [5]
- b) Define Polar Moment of Inertia and explain its significance in engineering mechanics. [5]

### Unit-4

- 8 a) A car accelerates from rest at  $2 \text{ m/s}^2$  for  $5$  seconds. It then maintains a constant velocity for  $10$  seconds before decelerating uniformly to rest in  $5$  seconds. Calculate the total distance travelled by the car. [5]
- b) A particle moves under the influence of a force  $F=-kx$ , where  $k=50 \text{ N/m}$ . If the particle starts at  $x=0.1 \text{ m}$  with zero initial velocity, calculate its maximum speed. [5]

(OR)

- 9 a) A 10 kg block is placed on an inclined plane making an angle of  $30^\circ$  with the horizontal. If the coefficient of friction is 0.2, determine the acceleration of the block down the incline. [5]
- b) A 15 kg block slides down a rough incline of  $30^\circ$  over a distance of 5 m. If the coefficient of friction is 0.3, calculate the work done against friction and the velocity of the block at the bottom. Assume it starts from rest. [5]

### Unit-5

- 10 a) A disk rotates about a fixed axis with an angular velocity of 10 rad/s. If it undergoes a constant angular acceleration of  $5 \text{ rad/s}^2$  for 4 seconds, find the final angular velocity and the total angular displacement during this period. [5]
- b) A 2 kg block slides down a frictionless incline from a height of 5 m. Calculate the velocity of the block at the bottom of the incline using the work-energy principle. [5]

(OR)

- 11 a) A car accelerates uniformly from rest to a speed of 20 m/s in 10 seconds. Calculate the acceleration of the car and the distance it travels in this time. [5]
- b) A 5 kg ball initially moving at 10 m/s is struck by a force that acts for 2 seconds, changing its velocity to 20 m/s. Calculate the impulse imparted to the ball and the average force exerted. [5]

\*\*\*\*\*