

**R13**

Code No: 111AC

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech I Year Examinations, September - 2023

**ENGINEERING MECHANICS**  
(Common to CE, ME, AE, AME, MIE)

Time: 3 hours

Max. Marks: 75

Note: i) Question paper consists of Part A, Part B.

ii) Part A is compulsory, which carries 25 marks. In Part A, answer all questions.

iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

**PART - A**

**(25 Marks)**

- 1.a) Discuss the difference between statics and dynamics in engineering mechanics. [2]
- b) Discuss the concept of free body diagrams and their importance in analyzing forces in engineering mechanics. [3]
- c) A wooden block weighing 50 N is placed on a horizontal surface. The coefficient of friction between the block and the surface is 0.3. What is the maximum frictional force that can act on the block? [2]
- d) Explain the concept of static and kinetic friction. How do these types of friction differ? Provide examples to illustrate each type. [3]
- e) Explain the concept of centroids in mechanics. How is the centroid of a two-dimensional shape determined? [2]
- f) Explain the difference between the centroid and the center of gravity of an object. Under what conditions do these two points coincide? [3]
- g) Discuss Newton's second law of motion and its application in the analysis of particle kinetics. Provide an example demonstrating the use of this law. [2]
- h) Discuss the concept of impulse and momentum in particle kinetics. How are these quantities related, and what are their practical applications in real-world scenarios. [3]
- i) Define mechanical vibrations and explain the basic elements of a vibrating system. [2]
- j) What is resonance in mechanical vibrations? Describe the conditions for resonance to occur and its potential consequences on a vibrating system. [3]

**PART - B**

**(50 Marks)**

- 2.a) Concurrent forces 3P, 7P and 5P act respectively along three directions, which are parallel to the side of an equilateral triangle taken in order. Determine the magnitude and direction of the resultant.
- b) If the X component is as shown in figure 1 of P is 893 N, determine P and its Y component. [5+5]

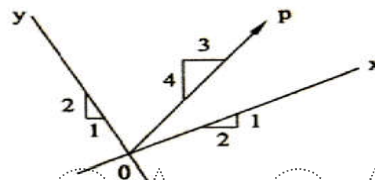


Figure.1

QA QA QA QA QA QA QA

OR

- 3.a) Find the magnitude and direction of the resultant  $R$  of four concurrent forces acting as shown in figure 2.

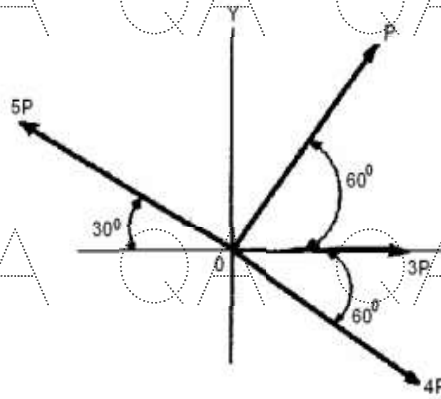


Figure. 2

- b) Find the reactions  $R_a$  and  $R_b$  induced at the supports A and B of the right angle bar ACB supported as shown in figure 3 and subjected to a vertical load  $P$  applied at the mid-point of AC. [5+5]

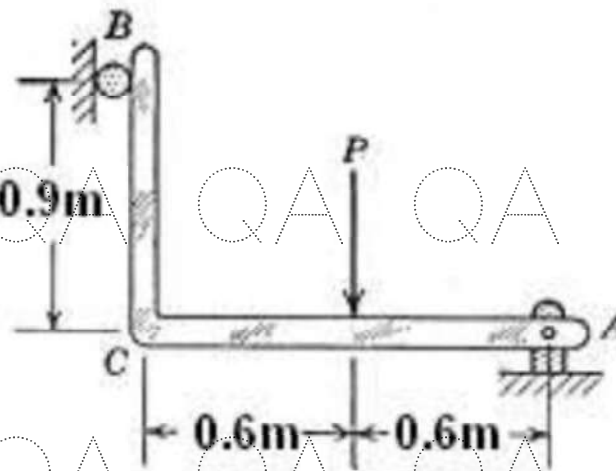


Figure.3

- 4.a) Deduce an expression for centrifugal tension of belt drive.  
b) The maximum allowed tension in a belt is 1500 N. The angle of lap is  $170^\circ$  and coefficient of friction between the belt and material of the pulley is 0.27. Neglecting the effect of centrifugal tension, calculate the net driving tension and power transmitted if the belt speed is 2 m/s. [5+5]

OR

QA QA QA QA QA QA QA

- 5.a) A ball of weight  $W$  rests upon a smooth horizontal plane and has attached to its center two strings AB and AC which pass over friction less pulleys at B and C and carry loads  $P$  and  $Q$ , respectively, as shown in the figure 4. If the string AB is horizontal, find the angle  $\alpha$  that the string AC makes with the horizontal when the ball is in a position of equilibrium. Also find the pressure  $R$  between the ball and the plane.

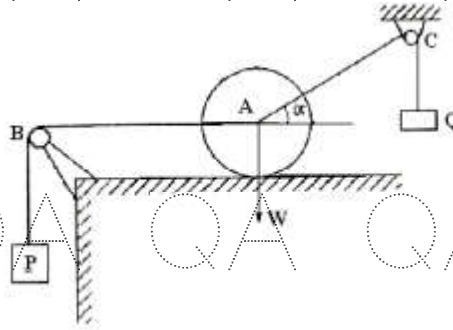


Figure. 4

- b) Two equal bodies A and B of weight ' $W$ ' each are placed on a rough inclined plane. The bodies are connected by a light string. If  $\mu_A = 1/2$  and  $\mu_B = 1/3$ , show that the bodies will be both on the point of motion when the plane is inclined at  $\tan^{-1}(5/12)$ . [5+5]
- 6.a) State and explain Pappus–Guldinus theorems for surface of revolution and volume of revolution.
- b) A circular plate of uniform thickness and of diameter 500 mm as shown in Figure 5 has two circular holes of 40 mm diameter each. Where should a 80 mm diameter hole be drilled so that the centre of gravity of the plate will be at the geometric centre. [5+5]

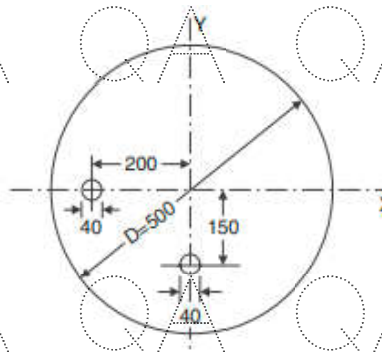


Figure 5

OR

- 7.a) A Cube of 400 mm has a mass density of  $2000 \text{ kg/m}^3$ . Find out the mass moment of inertia of the cube about its centroidal axis parallel to one of its sides.
- b) Determine the mass moment of inertia of a solid cone of height ' $h$ ' and base radius ' $r$ ' about its axis of rotation. [5+5]
- 8.a) A particle under a constant deceleration is moving in a straight line and covers a distance of 20 m in first two seconds and 40 m in the next 5 seconds. Calculate the distance it covers in the subsequent 3 seconds and the total distance covered, before it comes to rest.
- b) Deduce the general expression to determine the maximum height and horizontal range of projectile. [5+5]

OR

- 9.a) Block A has a weight of 300 N and block B has a weight of 50 N. Determine the speed of block A after it moves 2 m down the plane, starting from the rest.(Figure 6)

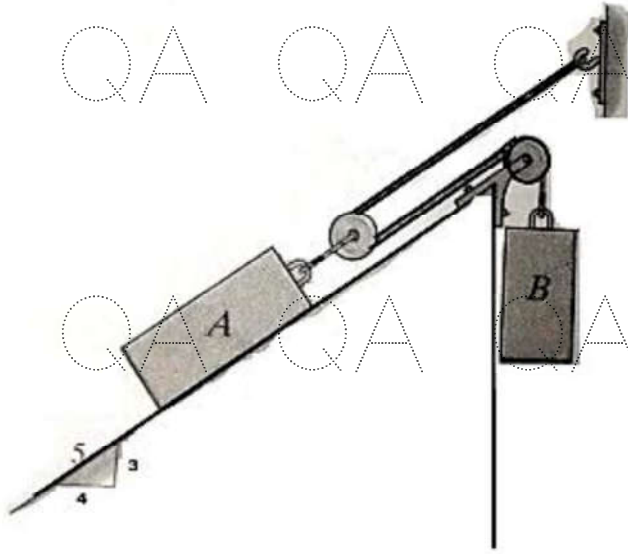


Figure.6

- b) A train of weight 1800 kN ascends a slope of 1 in 100 with a uniform speed of 40 kmph. If the track resistance is 5 N per kN of superimposed load, find the power spent by the engine. [5+5]

- 10.a) A body moves along a straight line and its acceleration 'a' which varies with time 't' is given by  $a = 6 - 4t$ . Five seconds after the start of observation, the velocity is 18 m/s. The distance moved by the body 8 sec after the start of observation of motion from origin is 75 m. Determine:

- i) The acceleration, velocity and distance from the origin at the start of observation.
- ii) The time after the start of observation at which the velocity becomes zero and the distance travelled from the origin.

- b) Two bodies A and B of mass 80 kg and 20 kg are connected by a thread and move along a rough horizontal plane under the action of a force 400 N applied to the first body of mass 80 kg as shown in Figure 7. The coefficient of friction between the sliding surfaces of the bodies and the plane is 0.3. Determine the acceleration of the two bodies and the tension in the thread, using D' Alembert's principle. [5+5]

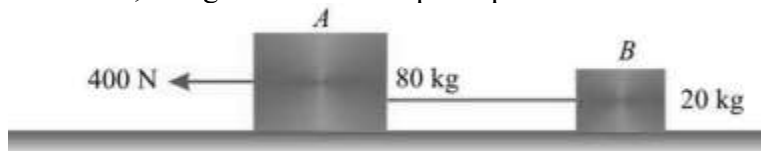


Figure. 7

- 11.a) A mass-spring system has a mass of 0.2 kg and is attached to a horizontal spring. The spring constant is 40 N/m. If the system is set into SHM with an amplitude of 0.1 meters, calculate the maximum speed and maximum acceleration of the mass.

- b) A roller coaster car, with a mass of 500 kg, starts from rest at the top of a hill with a height of 50 meters. Neglecting any energy losses due to friction or air resistance, calculate the maximum velocity of the car at the bottom of the hill. [5+5]