2021

ENGINEERING MECHANICS

Full Marks: 100

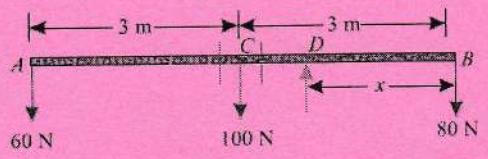
Time: 3 Hours

The figures in the margin indicate full marks for the Question

Answer any five questions

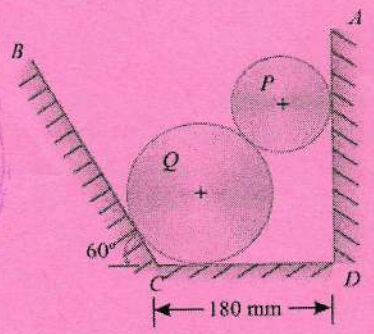
1.	a)	State the following Laws: i) Newton's second law of motion ii) Parallelogram law of forces iii) Triangle law of forces	1x3=3
	b)	State and explain varignon's principle	3
	c)	What is Lami's theorem? Derive the mathematical expression for Lami's theorem.	7
	d)	Define centroid and centre of gravity	3
	e)	What is free body diagram? State the conditions of equilibrium for a system of coplanar forces.	2+2=4
2.	a)	The resultant of two forces when they act at right angles is 10N. Whereas when they act at angle of 60° the resultant is √148 N. Determine the magnitude of the two forces	6
	b)	Four forces equal to P, 2P, 3P and 4P are respectively acting along the four sides of a square ABCD taken in order. Find the magnitude, direction and position of the resultant force	7
	c)	The following forces act at a point: i) 20N inclined at 30° towards North of East ii) 25N towards North iii) 30N towards North-West and iv) 35N inclined at 40° towards South of West Find the magnitude and direction of the resultant force.	7
3.	a)	A uniform beam AB of weight 100N and 6m long had two bodies of weight 60N and 80N suspended	5

from its two ends as shown in the figure below:



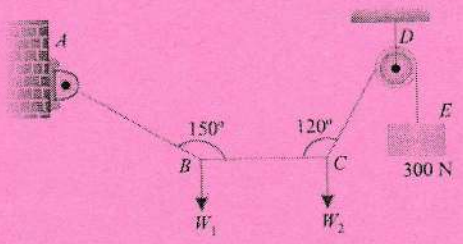
Find at what point the beam should be supported, so that it may rest horizontally.

b) Two Cylinders P and Q rest in a channel as shown in the figure below: 8
The cylinder P has a diameter of 100 mm and weighs 200n, whereas cylinder Q has diameter of 180mm and weighs 500N



If the bottom width of the box is 180 mm with one side vertical and the other inclined at 60°, determine pressures at all the four points of contact.

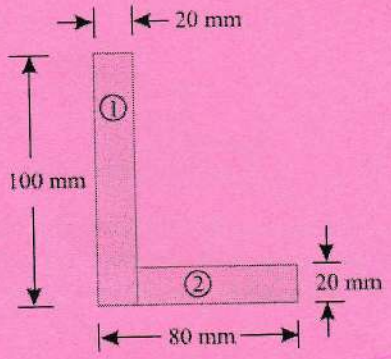
c) A light string ABCDE whose extremity A is fixed, has weights W_1 and W_2 attached to it at B and C. It passes round a small smooth peg at D carrying a weight of 300 N at the free end E as shown in the figure below: 7



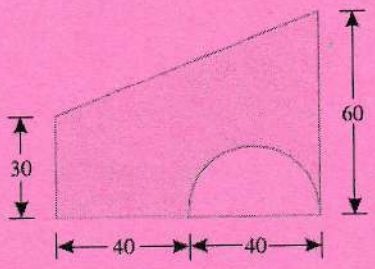
If in the equilibrium position, BC is horizontal and AB and CD make 150° and 120° with BC, find
i) Tensions in the position AB, BC and CD of the string
ii) Magnitudes of W_1 and W_2

4. a) Draw neat sketches of the centre of gravities (C.G.) of the following figures: 2x4=8
(i) Rectangle (ii) Trapezium (iii) Semi Circle
(iv) Circular Sector

b) Find the centroid of an unequal angle section 100mm X 80mm X 20 mm as shown in the figure below: 5



c) A semicircular area is removed from a trapezium as shown in the figure below: 7

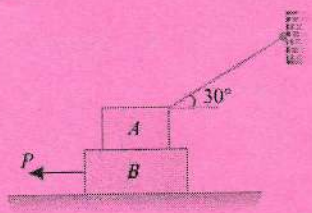


Determine the centroid of the remaining area.

5. a) Define limiting Friction and angle of Friction. 2+2=4

b) State the following: 2+2=4
i) Laws of static Friction
ii)Laws of dynamic Friction

c) Two blocks A and B of weights 1kN and 2 kN respectively are in equilibrium position as shown in the figure below: 6



If the coefficient of friction between the two blocks as well as the block B and the floor is 0.3, find the force (P) required to move the block B.

d) A body lying on a rough inclined plane subjected to a force acting along the inclined plane is in equilibrium state. Show that 6
(i) The minimum force which will keep the body in

equilibrium, when it is at the point of sliding downwards.

$$P_1 = \{ w \times \sin(\alpha - \varphi) \} / \cos\varphi$$

ii) The maximum force which will keep the body in equilibrium, when it is at the point of sliding upwards

$$P_2 = \{ w \times \sin(\alpha + \varphi) \} / \cos\varphi$$

6. a) A particle moves along along a straight line. Its motion is represented by the equation 9

$$S = 16t + 4t^2 - 3t^3$$

Where 'S' is in metres and 't' is in seconds.
Determine-
i) Displacement, velocity and acceleration 2 seconds after start.
ii) Displacement and acceleration when velocity is zero.
iii) Displacement and velocity when acceleration is zero.

b) A particle moves along a straight line with a velocity given by the equation 8

$$v = 2t^3 - t^2 - 2t + 4$$

Where 'v' is the velocity (m/s) and 't' is in sec.
When t=2 sec the particle is found to be at a distance of 10 m from a station.
Determine:
i) The acceleration
ii) Displacement of the particle after 6 seconds.

c) Define displacement, velocity and acceleration 3