

I B. Tech II Semester Regular/Supplementary Examinations, April/May - 2019
ENGINEERING MECHANICS
 (Com. to CSE, IT, AGE)

Time: 3 hours

Max. Marks: 70

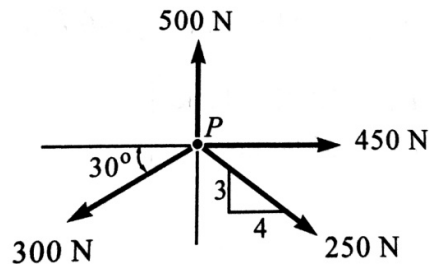
- Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
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PART -A

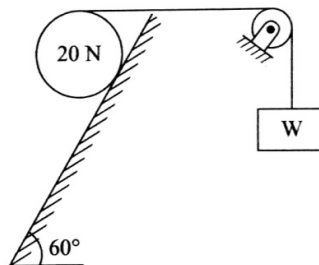
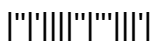
1. a) Define limiting friction and impending motion. (2M)
- b) What are the steps followed while drawing free body diagrams? (2M)
- c) What is the Centroid of a Quarter circle of radius 2 m? (2M)
- d) State perpendicular axis theorem. (2M)
- e) Distinguish between rectilinear motion and curvilinear motion. (2M)
- f) A man weighing 50 kg carries a load of 10 kg to the top of the building in 8 minutes. The work done by the man is 60 kJ. If he carries the same load in 4 minutes, how much work would he do? (2M)
- g) Explain the principle of impulse-momentum. (2M)

PART -B

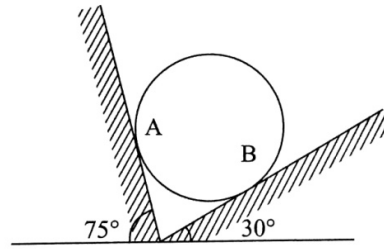
2. a) Find the resultant of the force acting on a particle P shown in figure. (5M)



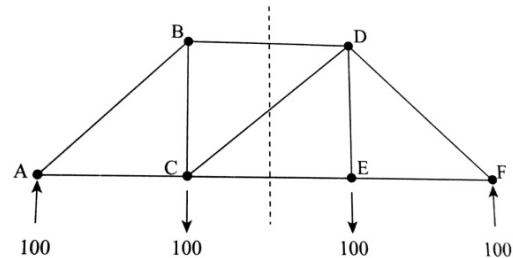
- b) A cylinder of radius 10cm and weight 20N, resting on an inclined plane, has a flexible string wrapped around it. The string does not slip over the cylinder, and is pulled by weight W to support the cylinder as shown in figure. If there is impending slippage, what is the coefficient of static friction between the cylinder and the incline? (9M)



3. a) A 20 kg homogeneous smooth sphere rests on two inclined planes as shown in figure. Determine the contact forces at A and B. (6M)

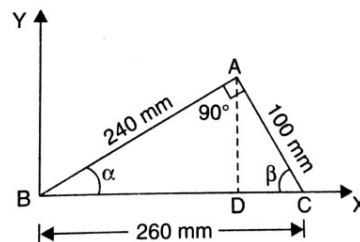


- b) Find the forces in members BD, CD and CE of the truss as shown in figure (the loads are indicated in newtons). (8M)

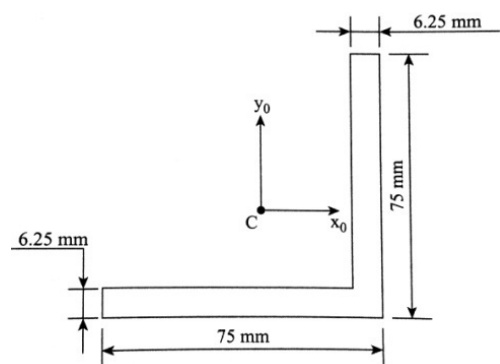


4. a) Locate the centroid of a circular sector of radius r and included angle 2α , selecting the symmetrical radial line as the x -axis. (6M)

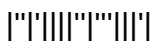
- b) A thin homogeneous wire is bent into a triangular shape ABC such that $AB = 240\text{mm}$, $BC = 260\text{mm}$ and $AC = 100\text{mm}$. locate the Center of Gravity of the wire with respect to coordinate axes. Angle at A is right angle. (8M)



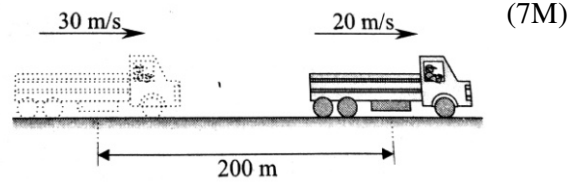
5. a) Determine the product of inertia with respect to the x_0 and y_0 axes passing through the centroid. (7M)



- b) Derive the expression for the moment of inertia of a homogeneous right circular cone of mass m , base radius r and altitude h with respect to its geometric axis. (7M)

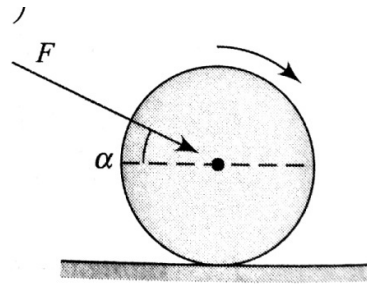
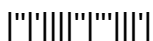


6. a) The speed of a truck moving at a constant speed of 30 m/s is reduced to 20 m/s in a distance of 200 m. Determine i) the acceleration assuming to be constant, and ii) the time taken to a stop with the acceleration calculated in part (i).



- b) An elevator weighing 6 tons together with the passengers descends with a speed of 4m/s. If the tension in the cable must not exceed 50kN, what is the shortest distance in which the elevator can be stopped? (7M)

7. A solid cylinder of weight 673kg and radius 37cm is pushed with a constant force $F=777\text{N}$, so that it rolls without slip on a rough inclined track having $\mu=0.31$ as shown in figure. To move starting from rest, how much distance will the cylinder take to attain a velocity of 7.7m/s? Take $\alpha=27^\circ$.



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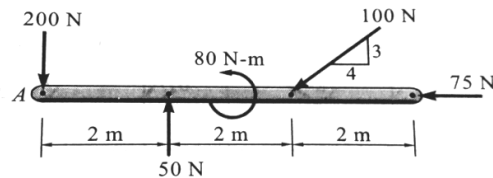
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PART -A

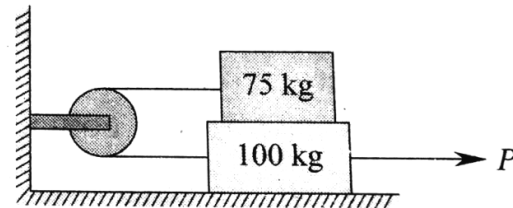
1. a) Define coefficient of friction and Cone of friction. (2M)
- b) Discuss the triangle law to determine the resultant of concurrent forces. (2M)
- c) Differentiate between Centroid and Center of gravity. (2M)
- d) Explain why moment of inertia is always positive while product of inertia can be positive or negative. (2M)
- e) Mention the equation of motion for rolling bodies. (2M)
- f) Under what situation, is it better to apply the principle of impulse-momentum rather than the principle of work-energy? (2M)
- g) State D'Alembert's principle. (2M)

PART -B

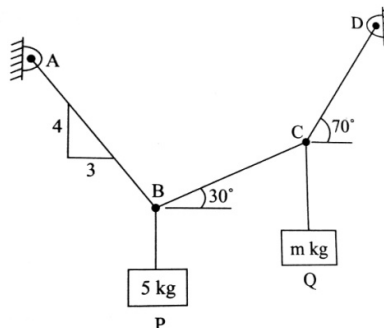
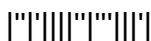
2. a) Replace the system of forces and couple shown in figure by a single force couple system at A. (7M)



- b) In figure, determine the horizontal force P applied to the lower block to just pull it to the right. The coefficient of friction between the blocks is 0.2 and that between the lower block and the plane is 0.25. Assume the pulley to be frictionless. (7M)

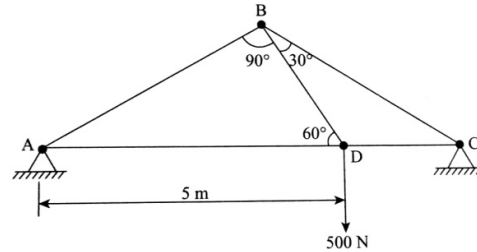


3. a) Block P of mass 5kg and block Q of mass m kg, suspended through a cord, are in the equilibrium position as shown in figure. Determine the mass m. (7M)



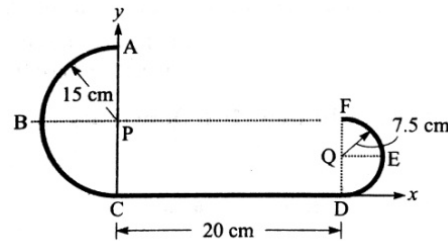
- b) A truss is loaded as shown in figure. Find the forces in members AB, BD and BC.

(7M)

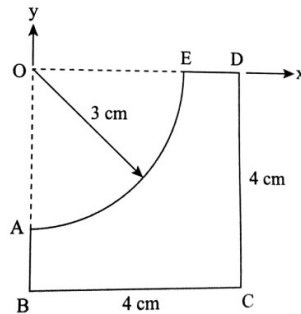


4. a) Determine the distance of the centroid from the base of a triangle of altitude h . (7M)

- b) A wire has been bent into the shape as shown in figure. Determine the position of the centroid of the wire. (7M)



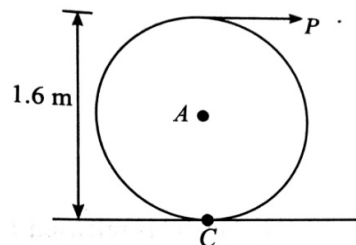
5. a) Calculate the polar moment of inertia of the area shown in figure about point O. (7M)



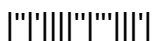
- b) Find the mass moment of inertia of a hollow cylinder about its axis. The mass of the cylinder is 5kg, inner radius 10cm, outer radius 15cm and height 20cm. (7M)

6. a) A stone is dropped into a well and the splash is heard after 3s. If the speed of sound in air is 340m/s, determine the depth of the well. (6M)

- b) A solid cylinder weighing 1300N is acted upon by a force P horizontally as shown in figure. Determine the maximum value of P for which there will be rolling without slipping (given $\mu=0.2$). (8M)



7. A road roller has a total mass of 12,000kg. The front roller has a mass of 2000kg, a radius of gyration of 0.4m and a diameter of 1.2m. The rear axle together with its wheels has a mass of 2500kg, a radius of gyration of 0.6m and a diameter of 1.5m. Calculate the kinetic energy of rotation of the wheels and axle at a speed of 9km/h and total kinetic energy of the road roller. (14M)



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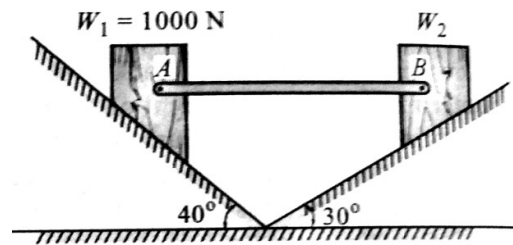
PART -A

1. a) Explain how to resolve a force in space to determine its components. (2M)
- b) State Lami's theorem. (2M)
- c) State Pappus theorem to find out the surface area and volume of a body. (2M)
- d) Differentiate between polar moment of inertia and product of inertia. (2M)
- e) Define curvilinear motion with suitable examples. (2M)
- f) Show that energy of a freely falling body is constant. (2M)
- g) Explain transfer formula for product of inertia. (2M)

PART -B

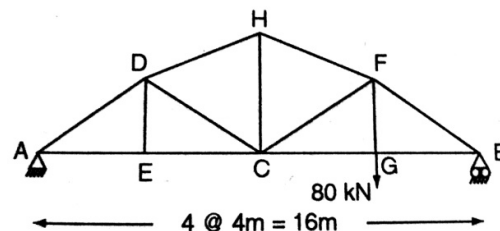
2. a) The resultant of two forces acting at a point is 75.71kN, where one force is double that of the other and if the direction of one is reversed, the resultant becomes 57.17kN. Find the magnitudes of two forces and the angle between them. (6M)

- b) Two blocks W_1 and W_2 resting on two inclined planes are connected by a horizontal bar AB as shown in figure. If W_1 equals 1000N, determine the maximum value of W_2 for which the equilibrium can exist. The angle of limiting friction is 20° at all rubbing faces. (8M)

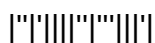


3. a) Three concurrent forces are acting on a body which is in equilibrium, then the resultant of the two forces should be equal and opposite to the third force. Prove this statement. (6M)

- b) Find the forces in members EC, DC and DH of the truss shown in figure. (8M)

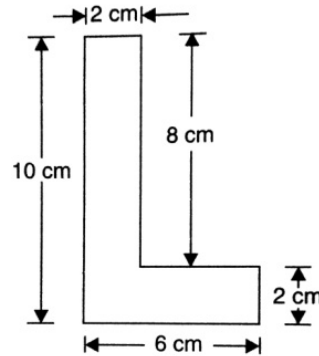


4. a) Locate the centroid of the area bounded by the two coordinate axes and a circle of radius a with its centre at $(0,a)$. (6M)



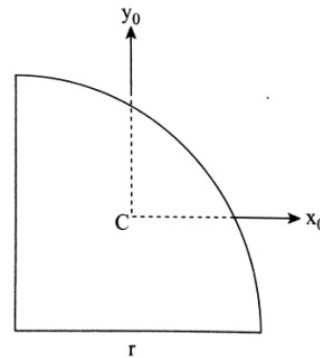
- b) Find the centre of gravity of the L-section shown in figure

(8M)



5. a) Determine the product of inertia of a quarter-circular area about its centroidal axes which are parallel to its edges.

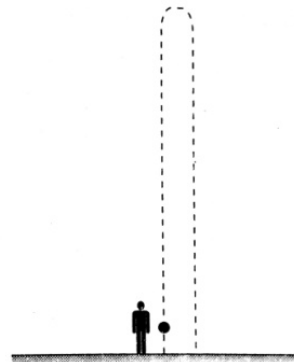
(7M)



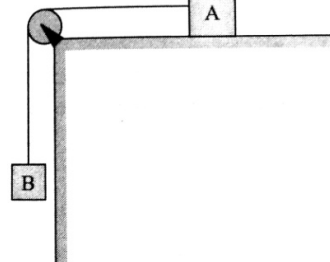
- b) Derive the mass moment of inertia of a rectangular plate about a line passing through the base. (7M)

6. a) A car covers 100m in 10 seconds, while accelerating uniformly at a rate of 1m/s^2 . Determine i) initial and final velocities of the car, ii) distance travelled before coming to this point assuming it started from rest, and iii) its velocity after the next 10 seconds. (7M)

- b) A ball is thrown vertically upwards from the ground with an initial velocity of 20m/s. Determine i) the maximum height reached by the ball, ii) the time taken to reach the maximum height, and iii) the total time of flight. (7M)



7. Two blocks A and B are connected with an inextensible but flexible string, as shown in figure. Let the system be released from rest. Determine the velocity of the block A after it has moved a distance of 0.7m. Assume that the coefficient of friction between block A and the plane is 0.31. The masses of the blocks are $m_A=95\text{kg}$ and $m_B=143\text{kg}$. (14M)



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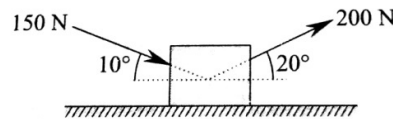
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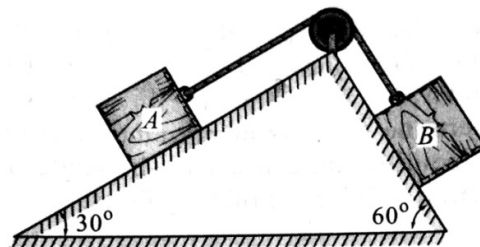
1. a) State Coulomb's law of dry friction. (2M)
- b) State the conditions of equilibrium for coplanar concurrent forces. (2M)
- c) What is the center of gravity of a cuboid with dimensions $(l, b, h) = (30, 40, 90)$ cm? (2M)
- d) Explain the term radius of gyration. What is its application? (2M)
- e) State the equations of equilibrium of a rigid body experiencing a planar motion. (2M)
- f) The work done upon a body by a system of forces causing uniform velocity is zero. Discuss. (2M)
- g) Draw the free body diagram of a block on a smooth inclined plane, is restricted from moving downwards by a string attached to it. (2M)

PART -B

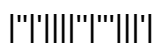
2. a) A 100kg box is shifted by two persons, one pulling it exerting a force of 200N inclined at 20° to the horizontal and another pushing it from behind by exerting a force of 150N inclined at 10° to the horizontal. Determine the resultant force acting on the box. Refer figure. (6M)



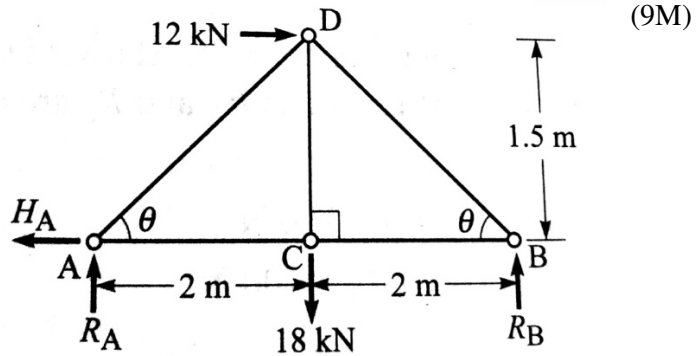
- b) Two blocks A and B are placed on inclined planes as shown in figure. The block A weighs 1000N. Determine minimum weight of the block B for maintaining the equilibrium of the system. Assume that the blocks are connected by an inextensible string passing over a frictionless pulley. Coefficient of friction μ_A between the block A and the plane is 0.25. Assume the same value for μ_B . (8M)



3. a) Explain the statement ``two equal and opposite parallel forces produces a couple``. (5M)

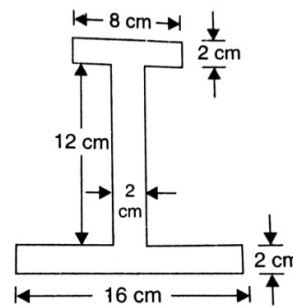


- b) Find the forces in all members of a truss as shown in figure which carries a horizontal load of 12kN at the point D and a vertical load of 18kN at the point C.

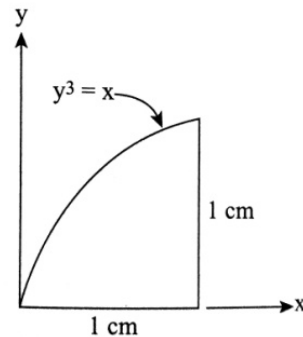


4. a) Locate the centroid of a semicircular disk of radius r . (6M)

- b) Find the centre of gravity of the I-section shown in figure? (8M)

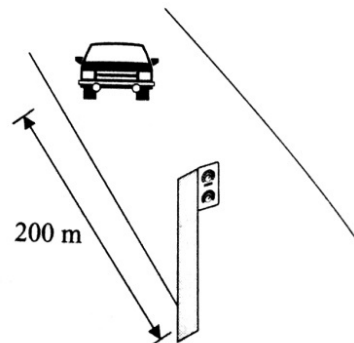


5. a) Determine the product of inertia I_{xy} of the area under the curve. (7M)



- b) Derive the mass moment of inertia of a right circular cone of base radius R , height H and mass M about its axis. (7M)

6. a) The driver of a car travelling at a constant speed of 10m/s sees the traffic signal ahead of him turning green, when he is at a distance of 200m from the signal. If the signal remains green for 15s, what should be his minimum acceleration in order to just cross the signal before the light turn's orange? Also, determine the speed with which he crosses the signal. (8M)



- b) An elevator together with the passengers weighing 2 tons is supported by a cable. Determine the acceleration of the lift when the tension in the cable is (i) 23 kN, when the lift is moving upwards and (ii) 18 kN, when it is moving upwards. (6M)

7. A train of weight 18,365kg moves down at a uniform speed of 36kmph, along an incline of slope 1:83 and develops a power of 40kW as shown in figure. If the train is pulled up at the same speed, determine the power required to pull the train.

(14M)

