Code No: R161216 **R16** SET - 1

I B. Tech II Semester Regular Examinations, April/May - 2017
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)**
2. Answering the question in **Part-A** is Compulsory
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) Define the terms: (i) Friction; (ii) Coefficient of friction. (2M)
   b) Give the necessary and sufficient conditions for the equilibrium of rigid body. (2M)
   c) With the help of a sketch, show where does the centroid of semi-circle lie. (2M)
   d) State Perpendicular axis theorem. (2M)
   e) Explain the difference between Rectilinear and Curvilinear motion. (2M)
   f) State the principle of impulse and momentum for a rigid body. (2M)
   g) Define the term Moment of inertia. (2M)

PART -B

2. a) Two forces of magnitude 50 N and 30 N are acting at a point. If the angle between the two forces is 60^0, determine the magnitude and direction of the resultant force. (7M)
   b) In the Figure 1, the two blocks (A=30 N and B=50 N) are placed on rough horizontal plane. Coefficient of friction between the block A and the plane is 0.3 and that between B and plane is 0.2. Find the minimum value of the force P to just move the system. Also find the tension in the string. (7M)

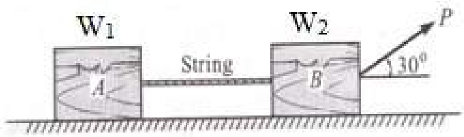

Figure 1

3. a) A force has the components F_x=100N; F_y=65N; F_z=-80N. Find the magnitude of the force and the angles θ_x ,θ_y and θ_z from the axes X, Y and Z respectively. (5M)
   b) Two smooth cylinders with diameters 250 mm and 400 mm respectively are kept in a groove with slanting surfaces making angles 60^0 and 30^0 as shown in the Figure 2. Determine the reactions at contact points A, B and C. (9M)

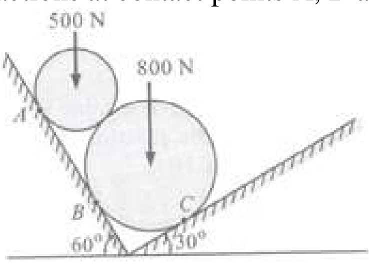

Figure 2
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4. a) Determine an expression for the center of gravity of a right circular solid cone about is base from first principles. (7M)
   b) Find the center of gravity of the shaded area as shown in the Figure 3. (7M)

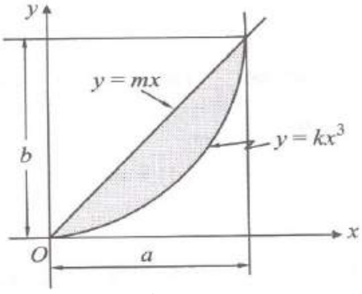

Figure 3

5. a) Derive an equation for moment of inertia of a Quarter circle. (7M)
   b) Find the Moment of Inertia about the centroidal axis in the given Figure 4. (7M)

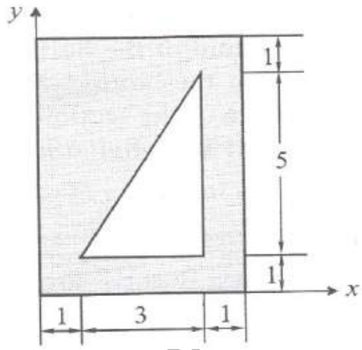

Figure 4

6. a) A wheel has an initial clock wise angular velocity of 8 rad/s and a constant angular acceleration of 2 rad/s^2. Determine the number of revolutions the wheel must undergo to acquire a clockwise angular velocity of 15 rad/s. What is the time required? (7M)
   b) Two trains P and Q leave the same station on parallel lines. Train P starts at rest with uniform acceleration of 0.2 rad/s^2 attains a speed of 10 m/s. Further the speed is kept constant. Train Q leaves 30 seconds later with uniform acceleration of 0.5 m/s^{2}from rest and attains a maximum speed of 20 m/s, when will train Q overtake train P. (7M)

7. An elevator weighs 10000 N when fully loaded. It is connected to 7500 N counter weight C and is powered by an electric wire as show in the Figure 5. Determine the power required when (i) the elevator is moving upward at constant speed of 20 m/s; (ii) the elevator is moving downward at a constant speed of 20 m/s and (iii) the elevator has an instantaneous velocity of 20 m/s upward and an upward acceleration of 3 m/s^2. (14M)

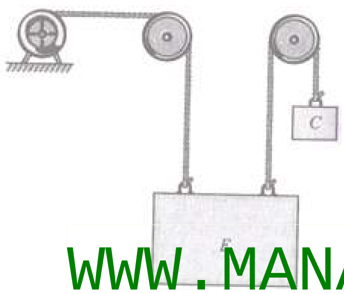

Figure 5

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2. Answering the question in **Part-A** is Compulsory
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) Define the terms: (i) Coulomb Friction; (ii) Angle of friction. (2M)
   b) State Lami's theorem. (2M)
   c) With the help of a sketch, show where does the centroid of a Trapezium lie. (2M)
   d) State Parallel Axis theorem. (2M)
   e) Write down the relationship between rectangular components and tangential and normal components of acceleration. (2M)
   f) How to find the total kinetic energy of the body, it the body has both translation and rotational motion. (2M)
   g) Define the term polar moment of inertia. (2M)

PART -B

2. a) Two forces of 80N and 70N act simultaneously at a point. Find the resultant force, if the angle between them is 150^0. (7M)
   b) Determine the necessary force P acting parallel to the plane to cause motion to impend as shown in the Figure 1. Assume coefficient of friction as 0.25 and the pulley to be smooth. (7M)

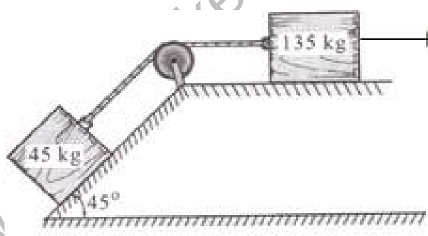

Figure 1

3. a) The force acts at the origin in a direction defined by the angles $\theta_y=60^0$ and $\theta_z=35^0$. Knowing that the X-component of force is -80 kN, determine (i) the other components and magnitude of forces; (ii) the value of θ_x. (5M)
   b) An electrical light weighing 15N hangs from a point C by the two strings AC and BC as shown in the Figure 2. AC is inclined at 60^0 to the horizontal and BC at 45^0 to the vertical. Using Lami's theorem, find the forces in the strings AC and BC. (9M)

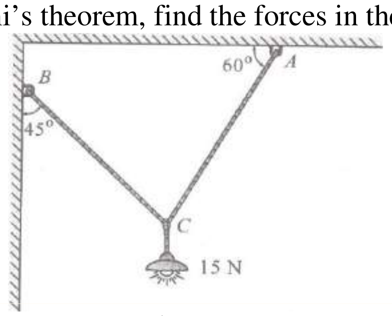

Figure 2
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4. a) Determine the centroid of the semi-circle whose radius is R. (7M)
   b) Determine the position of the center of gravity of the shaded area OBD as shown in the Figure 3. The curve OD is parabolic. (7M)

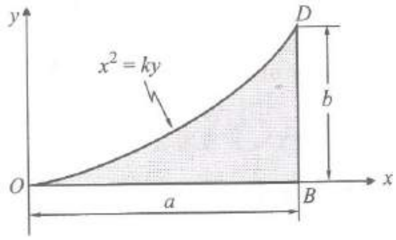

Figure 3

5. a) Describe the method of finding Moment of Inertia of composite areas. (7M)
   b) Find the Moment of Inertia about the centroidal axis in the given Figure 4. (7M)

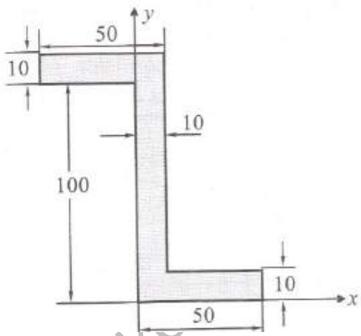

Figure 4

6. a) A wheel accelerates uniformly from rest to a speed of 200 rpm in ½ sec. It then rotates at that speed for 2 sec before decelerating to rest in 1/3 sec. How many revolutions does it make during the entire time interval? (7M)
   b) Two trains R and S start from rest simultaneously from stations A and B facing each other with accelerations 0.5 m/s^2 and 2/3 m/s^2 reaching their maximum speeds of 90 kmph and 72 kmph respectively. If they cross each other midway between the stations, find the distance between the stations and the time taken by each other. (7M)

7. a) Determine the power required for lifting a weight of 10 kN at constant speed of 2 m/s. If the velocity is later on increased to 3 m/s within a duration of 2 seconds. (5M)
   b) A projectile is fired with an initial velocity of 250m/s at a target located at a horizontal distance of 4km and vertical distance of 700 m above the gun. Determine the value of firing angle to hit the target. Neglect air resistance. (9M)

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PART –A

1. a) Define the terms: (i) Fluid Friction; (ii) Angle of repose. (2M)
   b) What do you understand by a "Free Body Diagram"? (2M)
   c) With the help of a sketch, show where does the centroid of Hemisphere lie. (2M)
   d) Define the term Moment of Inertia. (2M)
   e) Distinguish between translation and rotational motion. (2M)
   f) Define the motion of fixed axis rotation and give an example. (2M)
   g) Discuss the advantages of work-energy theorem. (2M)

PART -B

2. a) Three collinear horizontal forces of magnitude 150N, 450N and 300N are acting on a rigid body. Determine the resultant of forces when (i) all the forces are acting in the same direction; (ii) the force of 300N act in the same direction. (7M)
   b) In the given Figure 1, weights of two blocks A and B are 100N and 150 N respectively. Find the smallest value of the horizontal force F to just move the lower block B if (i) the block is restrained by a string; (ii) when the string is removed. (7M)

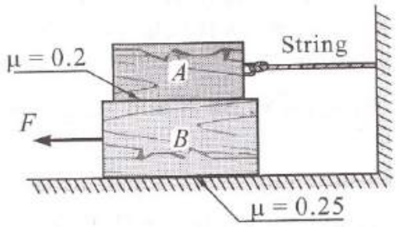

Figure 1

3. a) The x, y and z components of a force are 30 kN, -25kN and 20 kN respectively. Find the component of this force along the line joining A(2,3,-4) and B(-2,-3,3). (5M)
   b) Two smooth spheres of weight 100N and radius 250 mm each are in equilibrium each are in equilibrium in a horizontal channel of width 870 mm as shown in the Figure 2. Find the reactions at the surfaces of contact A, B, C, D assuming all surfaces to be smooth. (9M)

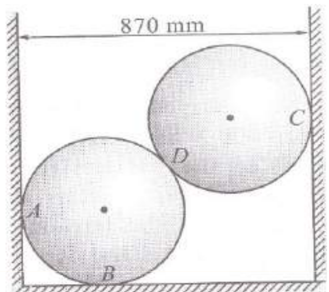

Figure 2
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4. a) Deduce an expression to determine the centroid of a triangle of base ‘b’ and height ‘h’. (7M)
   b) Find the center of gravity of the shaded area under the curve as shown in Figure 3. (7M)

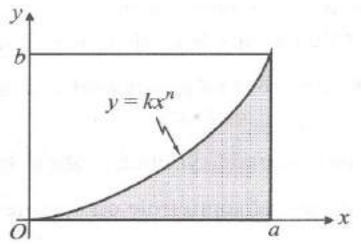

Figure 3

5. a) Derive an equation for moment of inertia of a Rectangle. (7M)
   b) Find the Moment of Inertia of the centroidal axis as shown in the Figure 4. (7M)

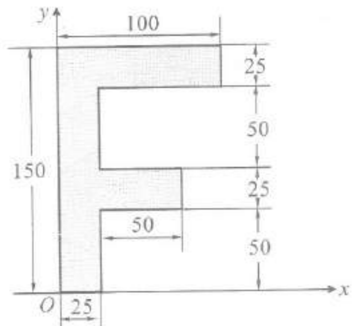

Figure 4

6. a) A fly wheel has its angular speed increased from 20 rad/s to 75 rad/s in 100 seconds. If the diameter of the wheel is 2 m, determine the normal and tangential components of the displacement of the point during this time period. (7M)
   b) A burglar’s car had a start with an acceleration of 2 m/s^2. A police vigilant party came after 5 seconds and continued to chase the burglar’s car with a uniform velocity of 20 m/s. Find the time taken, in which police will overtake the car. (7M)

7. Two blocks A and B of masses 10 kg and 5 kg are connected with cord and pulley system as shown in the Figure 5. Determine the velocity of each block when the system is started from rest and block B gets displacement by 2 m. Consider μ_k=0.2 between block A and horizontal surface. (14M)

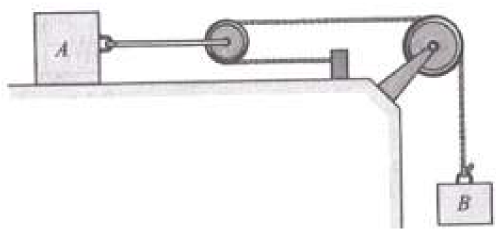

Figure 5

Code No: R161216 **R16** SET - 4

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PART –A

1. a) State the laws of Coulomb friction. (2M)
   b) How free body diagram is constructed? (2M)
   c) With the help of a sketch, show where does the centroid of right circular solid cone lie. (2M)
   d) Define the term Radius of Gyration. (2M)
   e) For a rotating body, define (i) angular velocity; (ii) angular acceleration. (2M)
   f) State the advantage of energy and momentum methods in the analysis of plane motion of rigid bodies. (2M)
   g) What do you mean by coplanar concurrent force system? (2M)

PART -B

2. a) The resultant of two concurrent forces is 2500N and the angle between the forces is 90^0. The resultant makes an angle of 46^0 with one of the forces. Find the magnitude of each force. (7M)
   b) Block A has a mass of 20 kg and block B has a mass of 10 kg in the Figure 1. Knowing that μ_s=0.15 between all surfaces of contact, determine the value of ϴ for which for which motion will impend. Take acceleration due to gravity = 10 m/s^2. (7M)

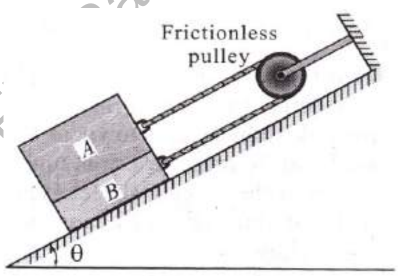

Figure 1

3. a) A force of 450N forms angles of 45^0, 120^0 and 60^0 with X, Y and Z axes respectively. Find the components F_x, F_y and F_z of the force. (5M)
   b) Two cylinders P and Q in a channel are as shown in the Figure 2. The cylinder P has a diameter of 100 mm and weight 200 N and Q has 180 mm and 500 N. Determine the reaction at all contact surfaces. (9M)

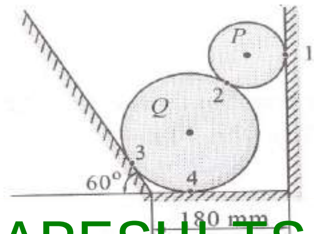

Figure 2
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Code No: R161216 **R16** SET - 4

4\. a) Determine the centroid of the quarter-circle whose radius is R. (7M)

b) Find the center of gravity of the shaded area shown in the Figure 3. (7M)

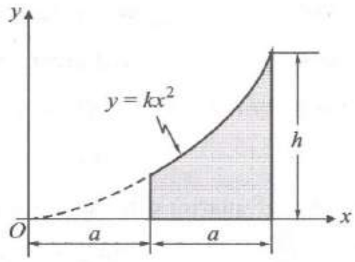

Figure 3

5\. a) Derive an equation for moment of inertia of a Circle. (7M)

b) Calculate the Moment of Inertia about the centroidal x and y for the section shown in the Figure 4. (7M)

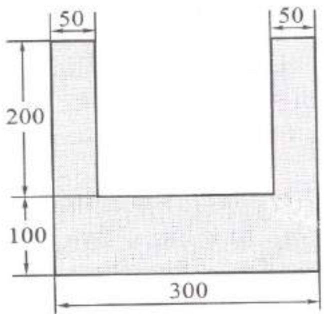

Figure 4

6\. a) The motion of a flywheel around its geometrical axis is described by the equation: $\omega=15t^2+3t+2$ rad/s and angular displacement is 160 radians at t=3 seconds. Find the angular acceleration, velocity, displacement at t = 1 second. (7M)

b) An aircraft moving horizontally at a speed of 360 kmph and at a height of 490 m towards a target on the ground, releases a bomb, which hits a target. Find (i) Time required for the bomb to reach the target on the ground; (ii) the velocity and the direction with which the bomb hits the target. (7M)

7\. Two blocks of masses M_1 and M_2 are connected by a string as shown in Figure 5. below Assuming the coefficient of friction between block M_1 and the horizontal surface to be μ if the system is released from rest, find velocity of the block A after it has moved a distance of 1 m Assume M_1=100kg.and M_2=150kg and μ =0.20. (14M)

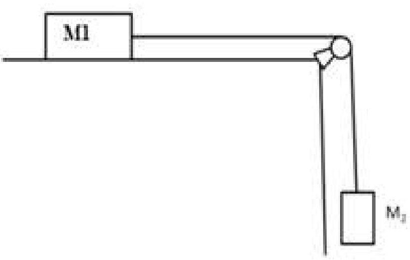

Figure 5