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

I B. Tech II Semester Regular/Supplementary Examinations, April/May - 2018
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 coefficient of friction. How is it related to angle of friction? (2M)

   b) State the necessary and sufficient conditions of equilibrium for a coplanar force system. (2M)

   c) Define the centre of gravity and centroid. (2M)

   d) Explain Polar moment of Inertia. (2M)

   e) Differentiate between kinematics and kinetics. (2M)

   f) Define Impulse and momentum. (2M)

   g) State the laws of friction. (2M)

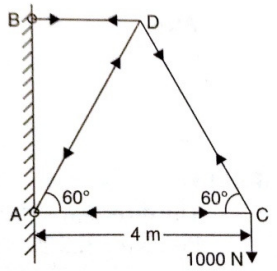
PART -B

2. a) Explain how will you reduce the system of coplanar, non-concurrent forces to a force and a couple. (6M)

   b) A uniform ladder of weight 800N and of length 7 m rests on a horizontal ground and leans against a smooth vertical wall. The angle made by the ladder with the horizontal is 60^0. When a man of weight 600N stands on the ladder at a distance 4m from the top of the ladder, the ladder is at the point of sliding. Determine the coefficient of friction between the ladder and the floor. (8M)

3. a) Three concurrent forces have magnitudes of 80 N, 120 N and 100 N respectively. Determine the angles among them that will produce a state of equilibrium. (6M)

   b) Determine the forces in all the members of a cantilever truss shown in the below figure. (8M)



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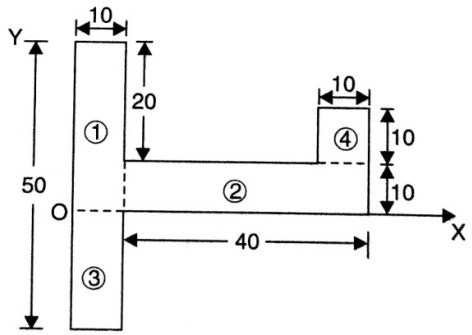
4. a) State and prove Pappus theorems of area and volume. (6M)

   b) Locate the Center of gravity of the area as shown in figure with respect to coordinate axes. All dimensions are in mm. (8M)



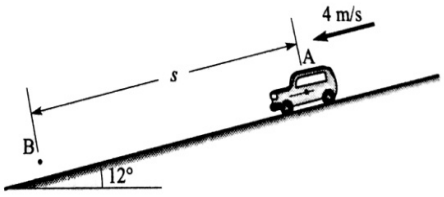
5. a) State and prove transfer formula for product of inertia. (6M)

   b) Find the mass moment of inertia of an aluminum pipe of 120mm outer diameter and 90mm inner diameter and 2.5m height about its longitudinal axis. (density, ρ=2560 kg/m^3). (8M)

6. a) A stone, dropped from a certain height, can reach the ground in 5s. It is stopped after 3 seconds of its fall and then allowed to fall again. Find the time taken by the stone to reach the ground for the remaining distance. (6M)

   b) A launcher fires a missile with a velocity of 60m/s at an angle with the horizontal. If the missile lands 323m away at the same level, determine the angle of projection. Also find the corresponding time of flight and the maximum height attained by the missile. (8M)

7. A car weighing 15 kN is travelling down a 12^0 inclined road at a speed of 4 m/s, as shown in the figure. To avoid an accident, the driver suddenly applies full brakes causing wheels to lock. Determine how far the tyres skid on the road, if the coefficient of kinetic friction between the tyres and the road is 0.6 (14M)



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

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PART –A

1. a) "Friction is independent of the area of contact between the two surfaces." Explain. (2M)

   b) Two forces are acting on a body and the body is in equilibrium. What conditions should be fulfilled by these two forces? (2M)

   c) State Pappus theorems. (2M)

   d) Explain area moment of inertia. (2M)

   e) When do we call a motion as rigid-body motion? (2M)

   f) State the principle of impulse-momentum. (2M)

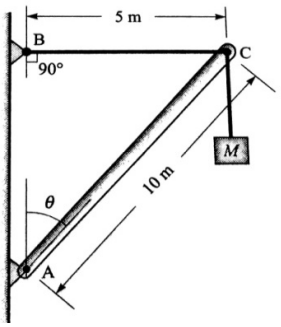
   g) Write the equilibrium equations for a concurrent force system in space. (2M)

PART -B

2. a) What do you understand by the term'Couple'? Discuss the characteristics of a couple. (6M)

   b) A pull of 60 N inclined at 25^0 to the horizontal plane, is required just to move a body placed on a rough horizontal plane. But the push required to move the body is 75N. If the push is inclined at 25^0 to the horizontal, find the weight of the body and coefficient of friction. (8M)

3. a) A 10 m boom supports a load of 600 kg, as shown in the figure. The cable BC is horizontal and 10 m long. Determine the forces in the boom and the cable. (8M)



   b) Discuss the assumptions made in the analysis of simple truss. (6M)
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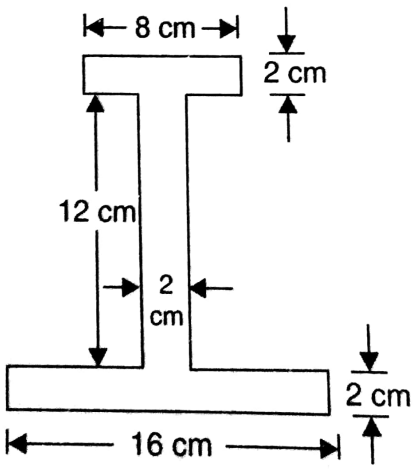
Code No: R161216 **R16** SET - 2

4. a) Discuss the procedure to find the location of the centre of gravity of a composite body. (6M)

   b) For the I-section shown in figure, find the moment of inertia about the centroidal axis X-X perpendicular to the web. (8M)

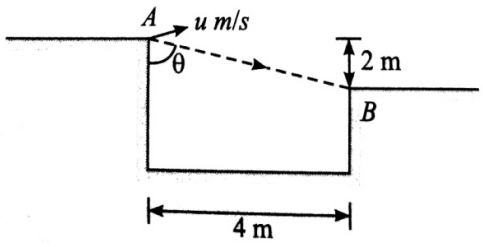


5. a) Find moment of inertia values of circle of radius 25mm about its centroidal XX and YY axes. (6M)

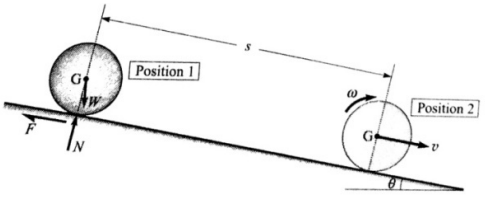
   b) Find the moment of inertia of an aluminum pipe of 150mm outer diameter and 120mm inner diameter and 3.5m height about its longitudinal axis YY.(density, ρ=2560 kg/m^3). (8M)

6. a) An elevator is moving upwards with a constant speed of 10m/s. If a man standing inside the elevator drops a coin from a height of 2.45m, find the time taken by the coin to reach the floor of the elevator. (g=9.8m/s^2). (6M)

   b) A motor cyclist wants to jump over a ditch as shown in figure. Find the necessary minimum velocity at A and also find the inclination and the magnitude of velocity of motor cycle just after clearing the ditch. (8M)



7. Three bodies – a sphere, a solid cylinder and a ring – each having same mass and radius are released from rest on a plane inclined at an angle θ as shown in figure. Determine the velocity of each body after it has rolled down (without slipping) the inclined plane through a distance s, and hence find the ratio of the three velocities. (14M)



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Code No: R161216 **R16** SET - 3

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PART –A

1. a) Define: (i) Cone of friction; (ii) Limiting friction. (2M)

   b) What are the conditions of equilibrium of a system of coplanar non-parallel, non-concurrent forces? (2M)

   c) What are the conditions under which the centre of gravity of a body becomes the same as its centroid? (2M)

   d) What is the significance of polar moment of inertia? (2M)

   e) State the assumptions made while studying projectile motion. (2M)

   f) State the work-energy equation for translation. (2M)

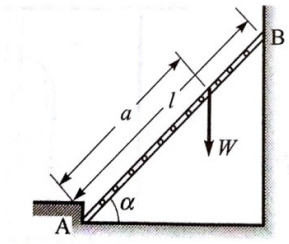
   g) Explain the statement, "Two equal and opposite parallel forces produces a couple". (2M)

PART -B

2. a) Explain the procedure to find the resultant of parallel forces. (6M)

   b) Three collinear horizontal forces of magnitude 300N, 100N and 250N are acting on rigid body. Determine the resultant of the forces when (i) All the forces are acting in the same direction; (ii) the force 100N acts in the opposite direction. (8M)

3. a) On a ladder supported at A and B, as shown in the figure, a vertical load W can have any position as defined by the distance *a* from the bottom. Neglecting friction, determine the magnitude of the reaction at B. Neglect the weight of the ladder. (8M)



   b) How will you prove that a body will not be in equilibrium when the body is subjected to two forces which are equal and opposite but are parallel? (6M)
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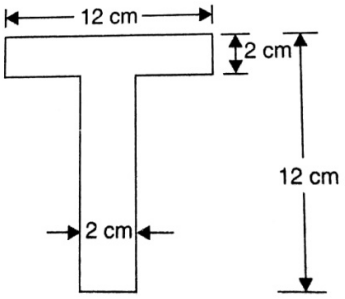
4. a) Determine the area generated by rotating a line of length `l` about x-axis from a distance `r` using Pappus theorem. (6M)

   b) For the T-section shown in figure, determine the moment of inertia of the section about the horizontal and vertical axes, passing through the centre of gravity of the section. (8M)



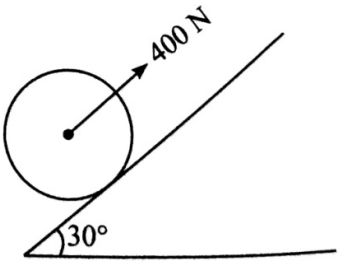
5. a) State and prove the parallel-axis theorem. (6M)

   b) Determine moment of inertia of a steel sphere 150mm diameter with respect to centre of gravity axes. Given density of steel as 7830 kg/m^3. (8M)

6. a) Two bodies start moving in the same straight line at the same instant of time from the same origin. The first body moves with a constant velocity of 40m/s, and the second starts from rest with constant acceleration of 4m/s^2. Find the time elapses before the second catches the first body. Also, find the greatest distance between them prior to it and the time at which this occurs. (7M)

   b) A particle undergoing central force motion has a tangential velocity of 20m/s while at a distance of 300m from the central point. Using the fact that the areal velocity of the particle must be constant, find its tangential velocity when it is 400m away from central point. (7M)

7. Find the work done in moving a 20 kg wheel by 2m up in an inclined plane with an angle of inclination equal to 30^0 with coefficient of friction 0.25, if a force of 400N is applied at the center of the wheel as shown in the figure. What will be the angular velocity of the wheel after the wheel has travelled 4 m up the plane? Take radius of the wheel to be 0.1 m. (14M)



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

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PART –A

1. a) Explain the phenomenon of friction by taking an example of a block placed on a rough surface. (2M)

   b) A number of forces are acting on a body. What are the conditions of equilibrium, so that the body is in equilibrium? (2M)

   c) What is the importance of axis of symmetry in determining the centre of gravity? (2M)

   d) What is the physical significance of moment of inertia? (2M)

   e) What do you understand by central force motion? (2M)

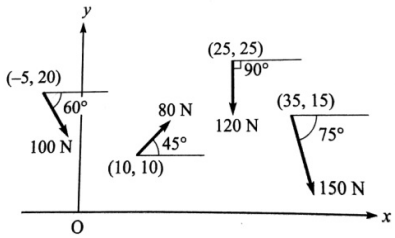
   f) Write the work-energy equation in case of fixed axis rotation. (2M)

   g) State D`Alembert`s principle. (2M)

PART -B

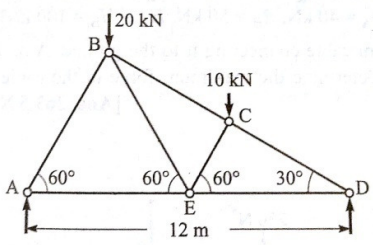
2. a) Show that the algebraic sum of the resolved parts of a number of forces in a given direction is equal to the resolved part of their resultant in the same direction. (6M)

   b) Determine the resultant of the force system shown in the figure. Assume that the coordinates of different points are in meters. (8M)



3. a) State and prove Lami's theorem. (6M)

   b) Find the forces in all the members of the truss given in the below figure. (8M)



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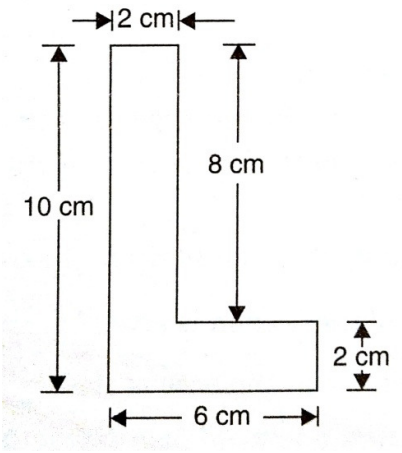
4. a) Determine the volume generated by rotating a semi-circular area of radius `r` about a non-intersecting axis using Pappus theorem. (6M)

   b) Find the centre of gravity of the L-section shown in figure. (8M)

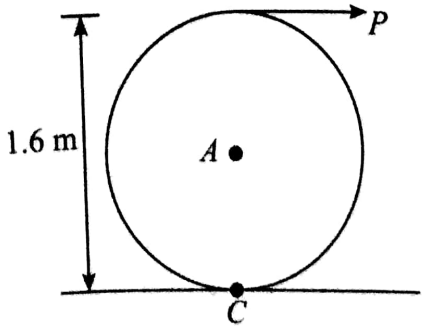


5. a) An isosceles triangle section ABC has a base of 100mm and 60mm height. Determine the moment of inertia of triangle about the centroid and about base. (6M)

   b) Determine moment of inertia of a cylinder shaft of 120mm diameter and 1.75m height about the centre of gravity XX, YY, ZZ axes. (density, ρ= 8000kg/m^3). (8M)

6. a) A vehicle running at 36km/h on a straight road accelerates uniformly to 72km/h over a distance of 200m. Determine the acceleration and time taken. How much distance will be covered by the vehicle in the 5th second? (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. (coefficient of friction, μ=0.2). (8M)



7. A bullet of 25 g mass is fired with a speed of 400 m/s. What is its kinetic energy? If the bullet can penetrate 20 cm in a block of wood, what is the average resistance of the wood? If the bullet were fired into a similar block of 10 cm thick wood, what would be the exit speed? (14M)