Subject Code: R161111/R16 **Set No – 1**

I B. Tech I Semester Regular Examinations, Dec – 2016
ENGINEERING MECHANICS
(Com. to AE, AME, BOT, CHEM, CE, EEE, ME, MTE, MM, PCE, PE)

Time: 3 hours **Max. Marks: 70**

Question Paper Consists of Part-A and Part-B
Answering the question in Part-A is Compulsory
Four Questions should be answered from Part-B
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PART – A

1. a) Define equilibrium of motion. Write the equations for equilibrium. (2M)
   b) State the Laws of friction. (2M)
   c) Define centroid and centre of gravity. (2M)
   d) State the Parallel axis theorem. (2M)
   e) Write the equations of translation. (2M)
   f) Explain pappus theorem. (2M)
   g) State work-energy theorem for a system of particles. (2M)

PART – B

2. a) What are the laws to add two forces and several concurrent, coplanar forces? Explain in detail. (8M)
   b) A block weighing 100 N is resting on a rough plane inclined $20^0$to the horizontal. It is acted upon by a force of 50N directed upward at angle of 14^0above the plane. Determine the friction. If the block is about to move up theplane, determine the co-efficient of friction. (6M)

3. a) State and prove Lamis Theorem. (7M)
   b) Five strings are tied at a point and are pulled in all directions, equally spaced, fromone another. If the magnitude of the pulls on three consecutive strings is 70N, 40N and 55N respectively, find graphically the magnitude of the pulls on two otherstrings, if the system is in equilibrium. (7M)

4. a) Differentiate between centroid and centre of gravity. (7M)
   b) Find the centroid of the Z section shown in Figure 1. (7M)

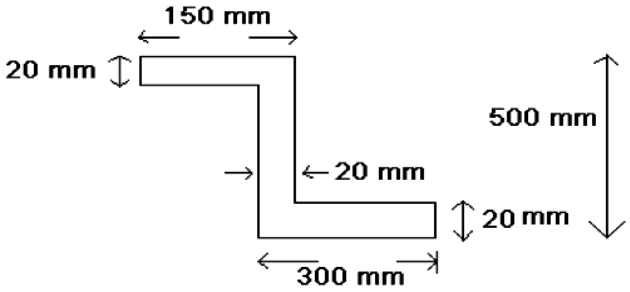

Figure 1

5. a) Find the moment of inertia of shaded area shown in Figure 2, below about centroidal axes. (7M)

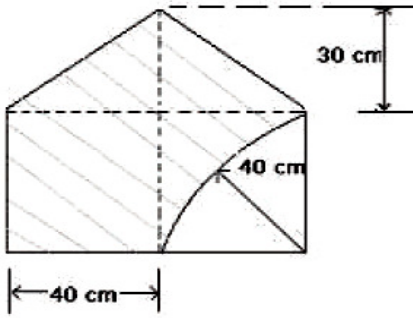

Figure 2

b) Find the mass moment of inertia of a hollow sphere with respect to a diameter if the mass per unit volume of the material is ρ and the outer and inner radii are $R_o$and R_i, respectively. (7M)

6. a) The weight of a body on earth is 980N. If the acceleration due to gravity on earth is 9.80m/s^2, what will be the weight of the body on (7M)
i) The moon, where gravitational acceleration is 1.6m/s^2 and
ii) The sun, where gravitational acceleration is 270 m/s^2.

b) A bullet of mass 80gm and moving with a velocity of 200 m/s is fired into a log of wood and it penetrates to a depth of 8cm. If the bullet moving with the same velocity were fired into a similar piece of wood 5cm thick, with what velocity would it merge? Also find the force of resistance assuming it to be uniform. (7M)

7. a) Derive work energy equation for translation. (5M)

b) A ball of mass 100gm is moving towards a bat with a velocity of 25m/s as shown in the Figure 3. When hit by the bat, the ball attains a velocity of 35m/s. If the ball and bat are incontact for a period of 0.02 sec, determine the average impulse force exerted by the baton the ball during the impact. (9M)

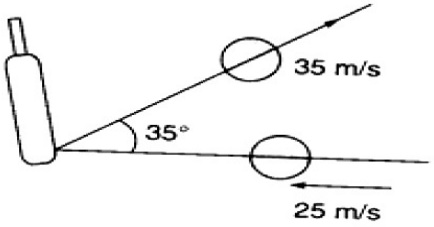

Figure 3

Subject Code: R161111/R16 **Set No – 2**

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Answering the question in Part-A is Compulsory
Four Questions should be answered from Part-B

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PART – A

1. a) State the conditions for equilibrium of a rigid body in three dimensions.
   b) State triangular law of forces. What is the use of this law?
   c) Define a Free Body Diagram. Give two examples.
   d) What is general plane?
   e) Write impulse momentum equation.
   f) What is a rolling body? Explain its importance.
   g) What is transfer theorem? Explain.

[7 x 2 = 14]

PART – B

2. a) Three forces of magnitude 150N, 300N and 500N are acting at the origin O (0,0,0) and are directed from the points A (3,2,4), B (3,-2,-4) and C (-1,-3,-4) respectively to the origin. Determine the magnitude of the resultant.
   b) Explain the types of friction with examples.

[8+6]

3. a) Two spheres, each of weight 1000N and radius 25cm rest in a horizontal channel of width 90cm as shown in the Figure 3(a). Find the reactions on the points of contact A, B and C.

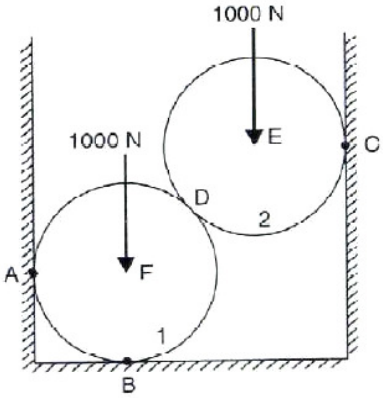

Figure. 3(a)

   b) A ladder 5m long and of 250N weight is placed against a vertical wall in a position where its inclination to the vertical is 30^0. A man weighing 800N climbs the ladder. At what position will he induce slipping? The co-efficient of friction for both the contact surfaces of the ladder viz. with the wall and the floor is 0.2.

[7+7]

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Subject Code: R161111/R16 **Set No – 2**

4. a) Locate the centroid of the shaded area as shown in the Figure 4(a).

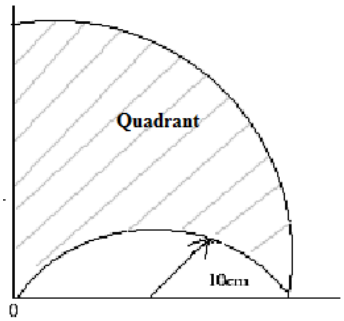

Figure. 4(a)

b) State and prove parallel axis theorem.

[8+6]

5. a) Find the moment of inertia about the horizontal centroidal axis of shaded portion as shown in the Figure 5(a).

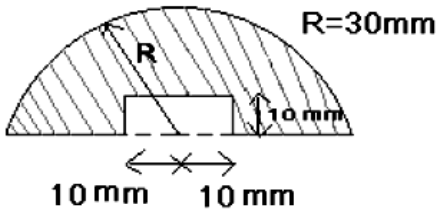

Figure. 5(a)

b) Deduce an equation for moment of inertia of right circular solid cone about its generating axes of base radius 'R' and altitude 'h'.

[7+7]

6. a) A train is uniformly accelerated and passes successive kilometer stones with velocities of 18km/hr and 36km/hr respectively. Calculate the velocity when it passes the third kilometer stone. Also find the time taken for each of the two intervals of one kilometer.

b) A body weighing 20N is projected up a 20^0 inclined plane with a velocity of 12m/s, coefficient of friction is 0.15. Find:
i) The maximum distance S, that the body will move up the inclined plane
ii) Velocity of the body when it returns to its original position.

[7+7]

7. A 6 kg block slides on a rough surface and come to rest. The deceleration is constant, initial velocity= 0.8m/s. Distance travelled before coming to rest = 2.5m.
a) Determine the value of friction coefficient.
b) An additional 2.5 kg block is fixed to the top of the 6 kg block. Assuming same initial velocity, find the distance travelled by the system before coming to rest.

[14]

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Subject Code: R161111/R16 **Set No – 3**

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Four Questions should be answered from Part-B

****

PART – A

1. a) State the converse of the law of triangle of forces.
   b) State the Varignon's theorem.
   c) Why static coefficient of friction is always greater than kinetic coefficient of friction?
   d) State D'Alembert principle giving equations.
   e) Define the term radius of gyration. Write the units.
   f) What is fixed axis rotation? Explain.
   g) Explain work-energy method for a plane motion. [7 x 2 = 14]

PART – B

2. a) A body weighing 70kN rests in equilibrium on a rough plane whose slope is 30^0. The plane is raised to a slope of 45^0. What is the force applied to the body parallel to the plane that will support the body on the plane?
   b) A right circular roller of weight W rests on a smooth horizontal plane and isheld in position by an inclined bar AC as shown in Figure 2(b). Find the tension S in the bar AC and the vertical reaction R_b at B if there is also a horizontal force P acting at C.

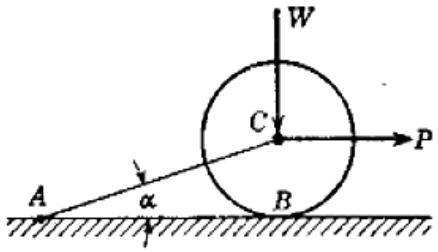

Figure. 2(b) [6+8]

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Set No – 3

Subject Code: R161111/R16

3. a) A system of forces consists of:
i) Force $P_1 = 3i + 5j – 6k$ acting through point (2,1,-3)
ii) Force $P_2 = 5i – 4j + 3k$ acting through point (1,4, 2) and a moment $M = 20i – 35j + 60k$.
The forces are in Newton (N) units, distances in 'm' units and the moment in 'N-m' units. Calculate:
A) The component of the resultant forces and its magnitude
B) The total moment of the system about the origin 'O'.
C) The moment of the system about the line through 'O' drawn in the 1st octant which makes angles of 65^0 and 75^0 with X and Y axes respectively.

b) A homogeneous semi-circular plate of weight 'W' and radius 'a' is supported by three vertical strings so that the plate is horizontal as shown in Figure 3(b). Determine the tensions in the three strings.

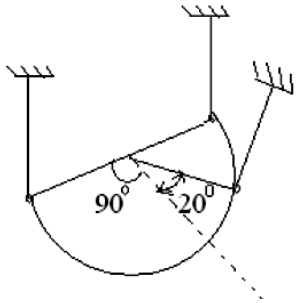

Figure. 3(b)

[7+7]

4. a) Differentiate between 'polar moment of inertia' and 'product of inertia'

b) Find the centroid of the area shown in Figure 4(b).

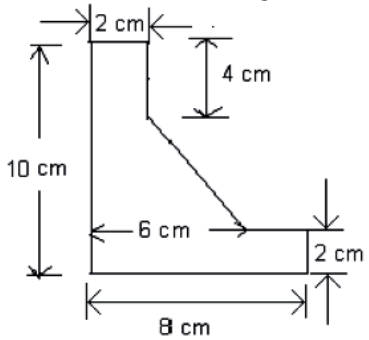

Figure. 4(b)

[6+8]

Subject Code: R161111/R16

Set No – 3

5. a) A uniform steel rod is bent into the shape of an isosceles triangle (OA = OB). Determine the mass moment of inertia about an axis through O perpendicular to the plane of the Figure 5(a). The total mass of the rod is 12 kg.

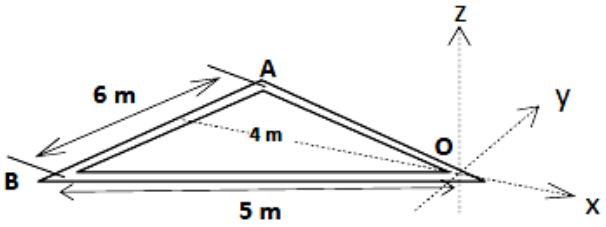

Figure. 5(a)

b) Derive the Moment of Inertia of a quarter circle of radius 'r' about the base and thecentroidal axes. [8+6]

6. a) Two blocks shown in Figure 6(a) below are originally at rest. Determine: (i) the acceleration of each block (ii) tension in cables. Assume the effect of friction in the pulleys, between the blocks and inclines as negligible. Mass of the pulley can also be neglected.

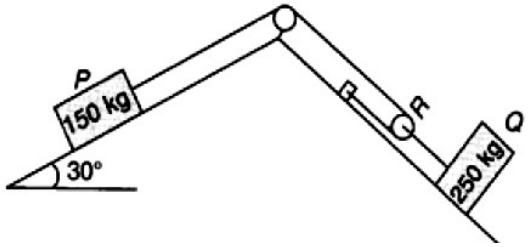

Figure. 6(a)

b) A car travelling at a speed of v= 60 kmph is braked and comes to rest in 8sec after the brakes are applied. Find the minimum coefficient of friction between the wheels and the road. [8+6]

7. a) Define work energy principle. Also derive the equation for work energy.

b) A man of weight 70kg standing at the end of a small boat of weight 35kg fires a bullet of mass 25gm to hit a wooden block of weight 2.25kg resting on the shore. If the bullet embedded block starts moving 5m/s, determine the velocity of the boat. [6+8]

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Subject Code: R161111/R16 **Set No – 4**

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****

PART – A

1. a) What is the principle of transmissibility?
   b) State the Lami's theorem.
   c) Define angle of repose.
   d) What is Polar moment of inertia and product of inertia?
   e) State the converse of the law of triangle of forces.
   f) Define D'Alembert Principle.
   g) What is the importance of impulse momentum method? [7 x 2 = 14]

PART – B

2. Find the least horizontal force 'P' to start motion of any part of the system of three blocks resting upon one another as shown in the Figure 3(a). The weights of the blocks are A = 3000N, B = 1000N, C = 2000N. Between A and B, μ = 0.3, between B and C, μ = 0.2 and between C and the ground, μ = 0.1.

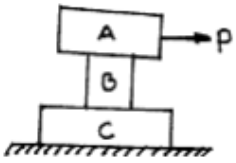

Figure 3(a)

[14]

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Subject Code: R161111/R16

Set No – 4

3. a) What is a force? Give classifications of system of forces.

   b) Determine the forces S_1 and S_2 induced in the bars AC and BC in Figure 2(b) due to the action of the horizontal applied load at C. The bars are hinged together at C and to the foundation at A and B.

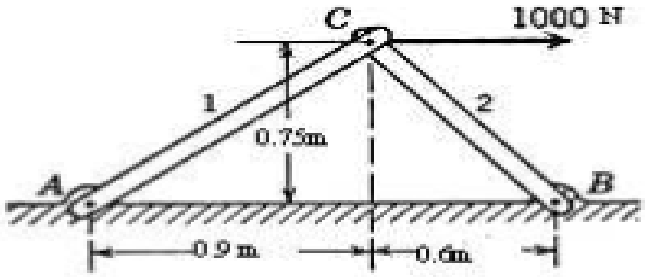

Figure. 2(b)

[6+8]

4. a) From the first principle find the centroid of a right angle triangle of height *h* and breadth *b*.

   b) Find the centroid of the area shown in Figure 4(b). All dimensions are in cm.

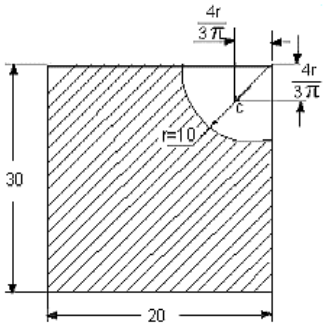

Figure. 4(b)

[7+7]

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5. a) Derive an expression to determine the moment of inertia of a semi-circle about its diametric base.
   b) Find the moment of inertia of the shaded area, as shown in Figure 5(b) about its centroidal axes parallel to x-axis.

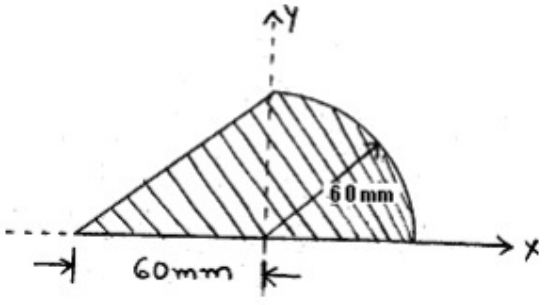

Figure. 5(b) [6+8]

6. a) The motion of a particle is defined by the relation $x = t^3 - 12t^2 + 36t + 30$ where x is expressed in meters and t is in sec. Determine the time, position and acceleration, when v = 0.
   b) A stone is thrown upwards from the top of a tower 70 m high with a velocity of 19.2 m/s. Determine its position and velocity when t = 6 seconds.

[7+7]

7. a) A 320 KN gain fires a 6 KN shell horizontally with a velocity of 300m/s. What is the recoil velocity of the gun? The recoil is overcome by applying an average fore of 500 KN. What is the distance travelled by the gun and the time taken?
   b) Explain briefly about work-energy method. [10+4]

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