Code No: R21031 **R10** SET - 1

II B. Tech I Semester Regular Examinations, March – 2014
ENGINEERING MECHANICS
(Com to ME, AE, AME, MM)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Explain lami's theorm?
   b) 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 $M = 20i - 35j + 60k$. Take the forces are in Newton (N), distances in 'm' and the moment in 'N-m'. Calculate:
   iii) The component of the resultant forces and its magnitude
   iv) The total moment of the system about the origin 'O'.
   v) 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. (3M+12M)

2. a) Explain cone of friction
   b) A block overlying a 10^0 wedge on a horizontal floor and leaning against a vertical wall and weighing 1500N is to be raised by applying a horizontal force to the wedge. Assuming the coefficient of friction to be 0.3, determine the minimum horizontal force to be applied to rise the block. As shown in the Figure-1. (3M+12M)

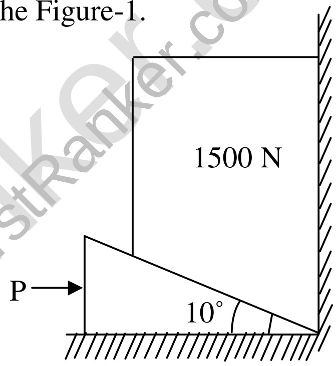

Figure 1

3. a) Derive the expression for Varagan's theorem.
   b) Two rollers of weights P and Q are connected by a flexible string DE and rest on two mutually perpendicular planes AB and BC, as shown in figure-2. Find the tension ('T') in the string and the 'θ' that it makes with the horizontal when the system is in equilibrium. The following numerical data are given. P= 270 N, Q = 450 N, $\alpha = 30^0$. Assume that the string is inextensible and passes freely through slots in the smooth inclined planes AB and BC. (5M+10M)

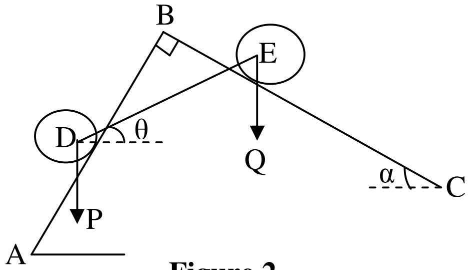

Figure 2
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Code No: R21031 **R10** SET - 1

4. a) State and prove parallel axis theorem.
   b) Find the centroid of the area shown in Figure-3. All dimensions are in cm. (5M+10M)

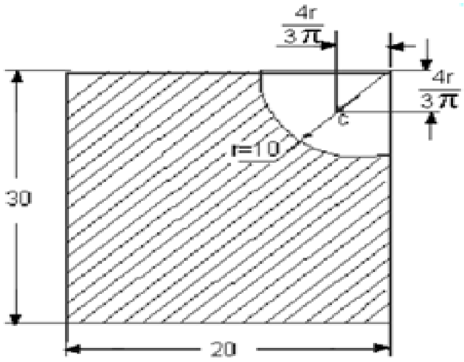

Figure-3

5. a) Define mass moment of inertia and explain Transfer formula for mass moment of inertia.
   b) For a built-up section shown in figure-4, work out the moment of inertia about the centroidal axes and their radius of gyration. (5M+10M)

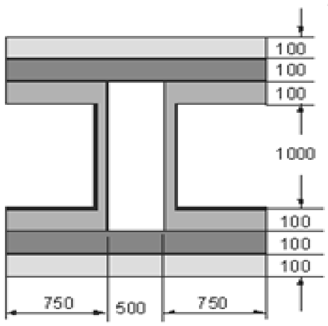

Figure-4

6. Calculate the forces included in the members of the pin-jointed truss shown in figure-5. Show the values on a neat diagram of the truss. Mention clearly the nature of the forces (tension or compression) in each case. (15M)

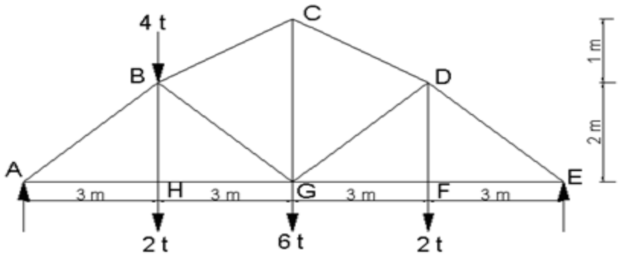

Figure-5

7. The motion of the particle is defined by the relation $x = 6t^4 + 8t^3 - 14t^2 - 10t + 16$, where x and t are expressed in meters and records, respectively. Determine the position, the velocity, and the acceleration as the particle when t = 3s. (15M)

8. A bullet is fired straight up from the surface of the moon with an initial velocity 620 m/s. Determine the mass elevation reached by the bullet.
   a) Assuming a uniform gravitational field with $g = 1.782\ m/s^2$
   b) Using Newton's law of gravitation. (Radius of moon = 1750 km). (7M+8M)

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1. a) Define i) free body diagram, ii) Transmissibility of a force and iii) resultant of a force.
   b) Three forces of magnitude 40 kN, 15 kN and 20 kN are acting at a point O as shown in Figure 1. The angles made by 40 kN, 15 kN and 20 kN forces with X-axis are 60^0, 120^0 and 240^0 respectively. Determine the magnitude and direction of the resultant force. (5M+10M)

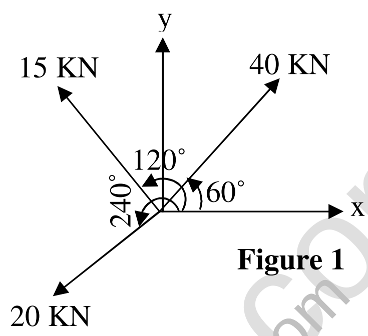

Figure 1

2. a) Explain the types of friction with examples.
   b) Two blocks of weight W_1 and W_2 rest on a rough inclined plane and are connected by a short piece of string as shown in Figure 2. If the coefficients of friction are $\mu_1 = 0.2$ and $\mu_2 = 0.3$, respectively, find the angle of inclination of the plane for which sliding will impend. Assume $W_1 = W_2 = 5$ N. (5M+10M)

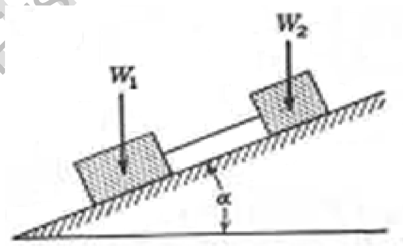

Figure-2

3. a) Define the terms i) centroid, ii) moment of inertia and iii) radius of gyration.
   b) Locate the centroid of the shaded area. As shown in the Figure-3 (5M+10M)

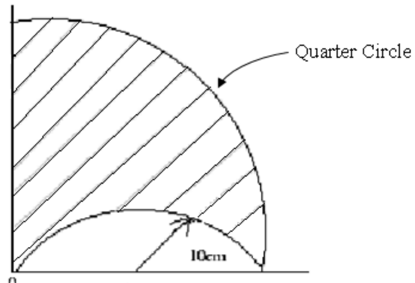

Figure-3
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Code No: R21031 **R10** SET - 2

4. a) Calculate the moment of inertia of the shaded area about the x – axis, As shown in the Figure 4.
   b) Determine the moment of inertia of a hallow circular section about its centroidal axes as shown in Figure 5. (7M+8M)

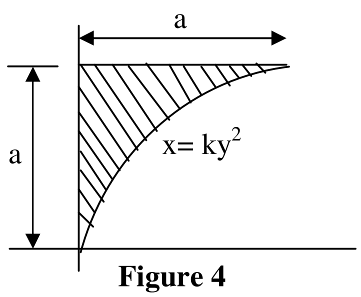

Figure 4

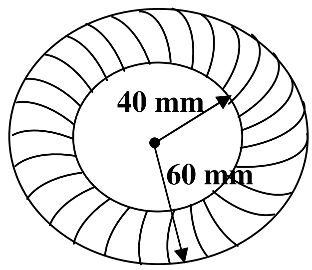

Figure 5

5. A cylinder of diameter 400mm and height 1000mm rests vertically. Over this, a cone of base diameter 400mm and height 500mm is placed such that the axis of the cone coincides with the axis of the cylinder. Find out the mass moment of inertia of this composite solid about a line which passes through the vertex of the cone and which is parallel to the base of the cylinder if the mass density is 4000kg/m^3. (15M)

6. Determine the forces induced in the members of the pin-jointed truss shown in figure-6. Show the values on a neat diagram of the truss. Mention clearly the nature of the forces (tension or compression) in each memeber. (15M)

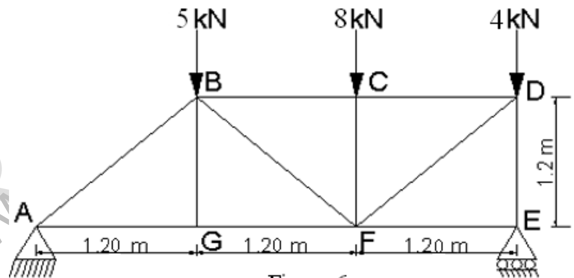

Figure-6

7. A projectile is fired from the edge of a 140m cliff with an initial velocity of 180 m/s at an angle of 30^0 with the horizontal. Neglecting air resistance, find
   a) The horizontal distance from the gun to the point where the projectile strikes the ground.
   b) The greatest elevation above the ground reached by the projectile (8M+7M)

8. A space craft describing an elliptic orbit about a planet has a maximum speed V_A = 10 km /sec. at its minimum attitude h_A = 1930km above the surface of the planet and a minimum speed V_B = 2 km/sec. at its maximum altitude h_B = 26200 km Determine: i) The radius of the planet ii) Mass of the plant. (15M)

Code No: R21031 **R10** SET - 3

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1. Two smooth spheres, each of radius, r and weight Q, rest in a horizontal channel having vertical walls, the distance between which is b. Find the pressures exerted on the walls and floor at the points of contact A, B and D. The following numerical data are given: r = 25 cm, b = 90 cm, Q = 100 N. As shown in the Figure-1. (15M)

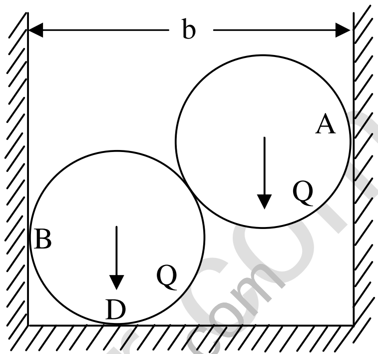

Figure 1

2. Four parallel forces of magnitudes 25 N, 50 N, 75 N and 100 N are shown in Figure-2. Determine the magnitude of the resultant and also the angle of the resultant from the line OA. (15M)

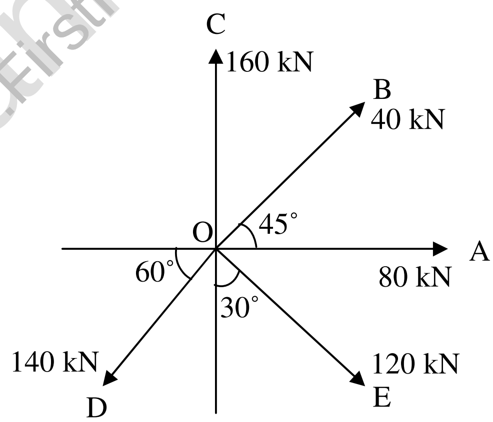

Figure 2

3. A block of weight W_1=1000N rests on a horizontal surface and supports on top of it another block of weight W_2 =250N as shown in Figure-3. The block W_2 is attached to a vertical wall by the inclined string AB. Find the magnitude of the horizontal force 'P' applied to the lower block as shown, that will be necessary to cause slipping to impend. The coefficient of static friction for all contact surfaces is μ=0.3. (15M)
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Code No: R21031 **R10** SET - 3

4. Find the centroid of the plane area shown in figure-4 (15M)

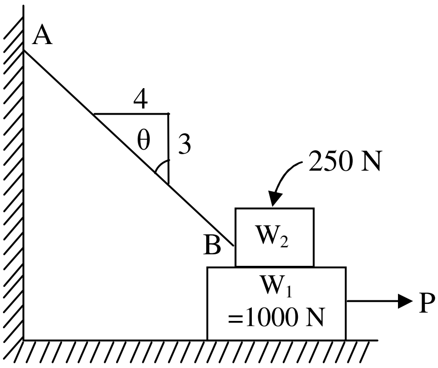

Figure 3

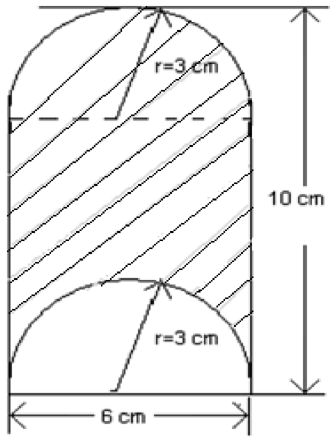

Figure-4

5. Find the product of inertia about X and Y axes of the area as shown in Figure-5. (15M)

6. Find the axial forces in all the members of a truss shown in figure-6. (15M)

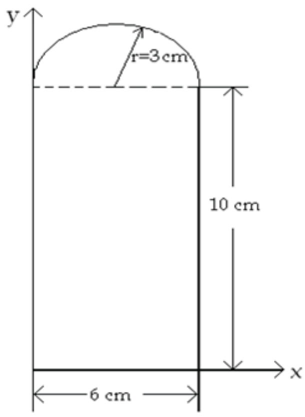

Figure-5

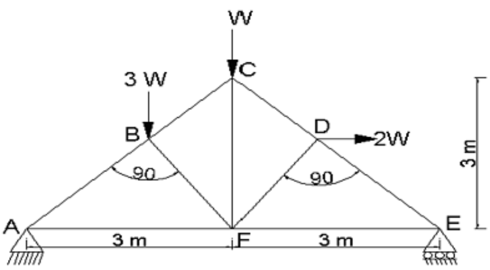

Figure-6

7. Show that there are two directions in which a particle may be projected at the same velocity so that it passes through a given target. Establish the minimum velocity of projection requirement such that the particle does reach the target. (15M)

8. A car of weight 2100kg starts from rest at point A on a 60 incline travels coasts through a distance of 140m to point B. The brakes are then fully applied, causing the automobile to skid to a stop at point c, 18m from B. The coefficient of dynamic friction between the tires and the road is 0.75, determine the work done on the automobile by the combined effects of air resistance and rolling resistance between points A and C. (15M)

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1. A rod AB shown in Figure-1 is held by a ball and socket joint at A and supports a mass C weighing 1200 N at end B. The rod is in x-y plane and is inclined to y axis at an angle of 15^0. The rod is 10m long and has negligible weight. Find the forces in the cables DF and EB. (15M)

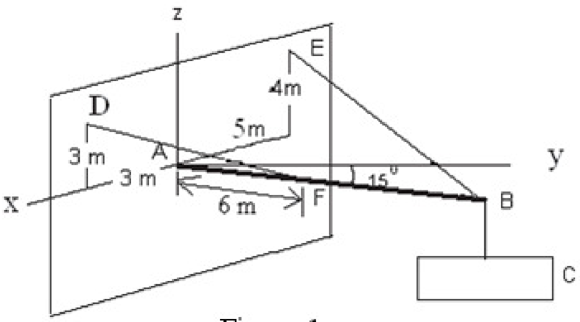

Figure-1

2. a) Two forces of 2kN and 5kN with an included angle of 300^0 between the lines of action act at a point A. Determine the magnitude and direction of the resultant.
   b) Describe the graphical method for the equilibrium of coplanar forces. Explain with an example of having three concurrent forces at a point. (7M+8M)

3. A smooth circular cylinder of weight Q and radius r is supported by two semicircular cylinders each of the same radius r and weight Q/2, as shown in Figure-2. If the coefficient of static friction between the flat faces of the semicircular cylinders and the horizontal plane on which they rest is $\mu = 0.5$ and friction between the cylinders themselves is neglected, determine the maximum distance b between the centers B and C for which equilibrium will be possible without the middle cylinder touching the horizontal plane. (15M)

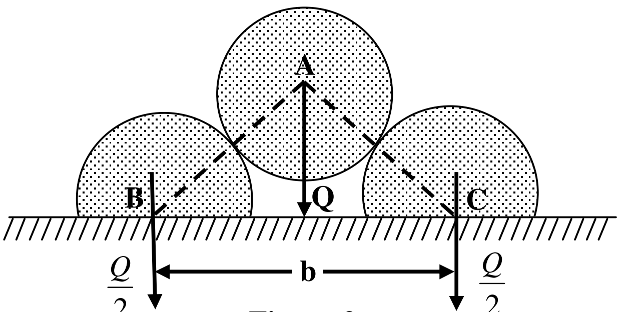

Figure 2
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4. Find the centroid of the area shown Figure-3. (15M)

5. Find the moment of inertia of the built-up section shown in figure- 4 about the centroidal X and Y axes. (15M)

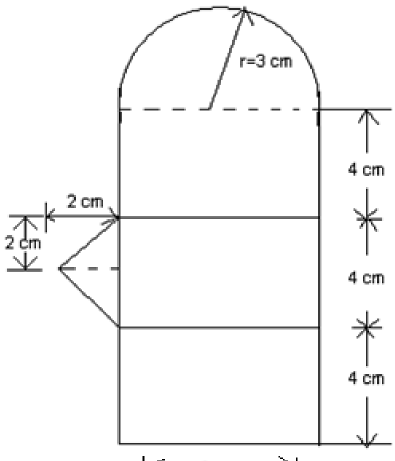

Figure-3

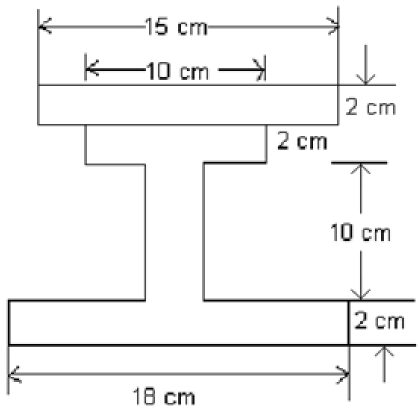

Figure-4

6. Calculate the forces included in the members of the truss shown in Figure-5. Indicate its nature of forces? (15M)

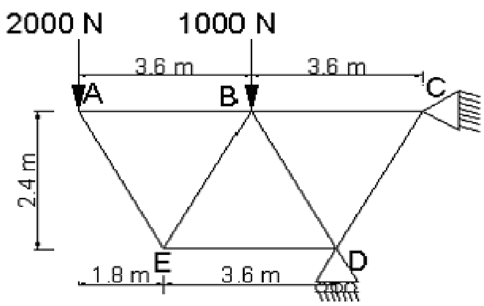

Figure-5

7. A train weighing 1900 kN without the locomotive starts to move with contact acceleration along a straight horizontal track and in the first minute acquires a velocity of 50 kmph. Determine the tension S in the draw bar between the locomotive and train if the total resistance to motion due to friction and air resistance is constant and equal to 0.005 times the weight of the train. (15M)

8. The motion of a disk rotating about a fixed point is given by the relation $\theta = 2(1 + e^{-3t})$ where θ is in radians and 't' is in seconds. Determine the angular coordinates, velocity and acceleration of the disk when i) t=0 and ii) t=2secs. (15M)