Subject Code: R13210/R13 **Set No - 1**

I B. Tech II Semester Regular Examinations August - 2014

ENGINEERING MECHANICS

(Common to ECE, EEE, EIE, Bio-Tech, E Com.E, Agri. E)

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

Question Paper Consists of **Part-A** and **Part-B**
Answering the question in **Part-A** is Compulsory,
Three Questions should be answered from **Part-B**

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PART-A

1.(i) Define Cone of friction.
(ii) State the two theorms of Pappus.
(iii) State work-energy theorem for a system of particles.
(iv) Derive the transfer formula for product of inertia.
(v) State the converse of the law of triangle of forces
(vi) Express the mass moment of inertia of a thin plate in terms of its area moment of inertia.
(vii) Develop velocity -time and displacement - time equations for a particle of weight W moving rectilinearly under the action of a force $F = F_o Sin\omega t$ if the initial displacement and velocities are zero each.

[2+4+3+4+2+3+4]

PART-B

2.(a) If a rod of length 3R is placed horizontally in a hemispherical bowl of radius R, determine the angle α the rod will make with the horizontal for the rod to be in equilibrium. Neglect friction between the bowl and the rod and assume that the bowl does not rock. see Fig. 1.

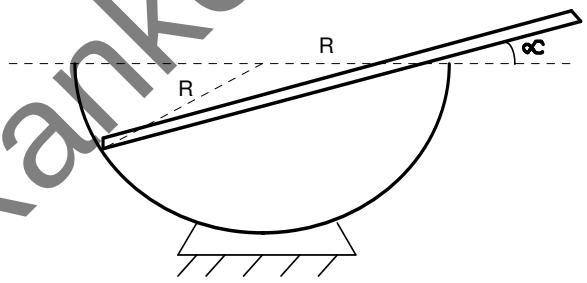

Fig. 1

(b) Determine the centroid of the line y = 1-x.

[10+6]

3.(a) A double wedge system is used to position the 800 kg shown in Fig.2. Neglecting the mass of the wedges, determine the minimum force P required t initiate movement. The coefficient of static friction between the 10 degrees wedges and all other surfaces is 0.25 and between the crate and the floor is 0.5.

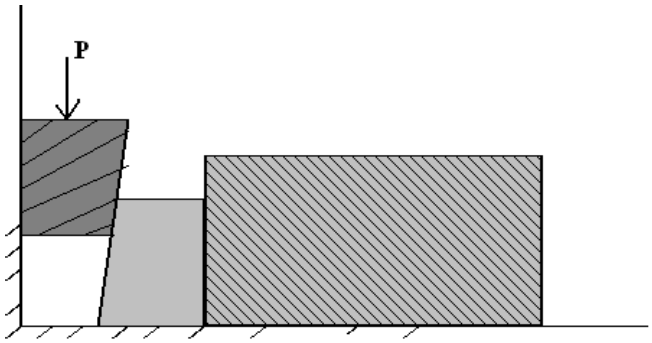

Fig. 2

(b) A car makes a left turn from a stopped position, increasing its speed at a rate of 1.5 m/s^2. If a book is on the dashboard of the car, at what time will the book to slide if the coefficient of static friction between the book and the dashboard is 0.25. The radius of the curve of motion is 8 m.

[8+8]

4.(a) Determine the center of gravity of a hemisphere of radius R.

(b) A ball is thrown with an initial velocity of V_o parallel to the rough plane as shown in Fig.3. The initial angular velocity is zero. Determine when the sphere will roll without slipping, and find the linear velocity of the ball at that time.

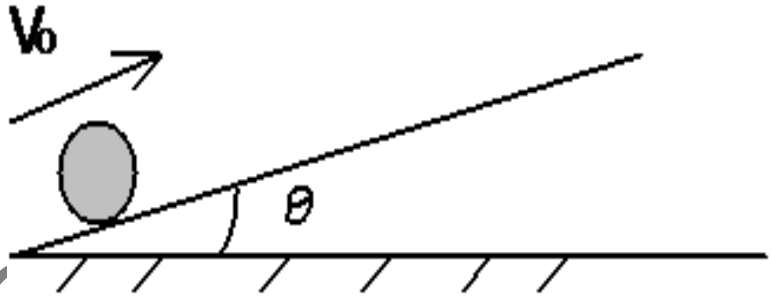

Fig.3

[8+8]

5.(a) A prismatic bar AB of weight W and length $l = \sqrt{2}\, r$ starts from rest in the position shown in Fig. 4 and under the action of gravity slides without friction along the constraining vertical plane curve ABD, the portion AB of which is a quadrant of a circle of radius r and the portion BD of which is a horizontal tangent to this circle. With what uniform velocity V will the bar move along the horizontal portion BD?

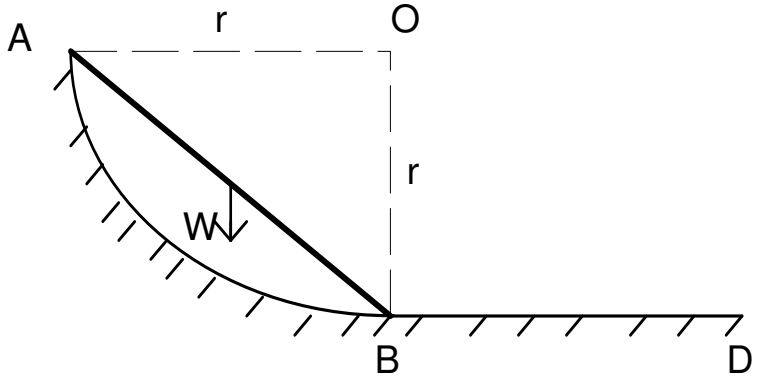

Fig. 4

(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.

[8+8]

6.(a) The barge B weighs 160 kN and supports an automobile weighing 16 kN. If the barge is not tied to the pier P and someone drives the automobile to the other side of the barge for unloading, determine how far the barge moves away from the pier. Neglect the resistance of the water.

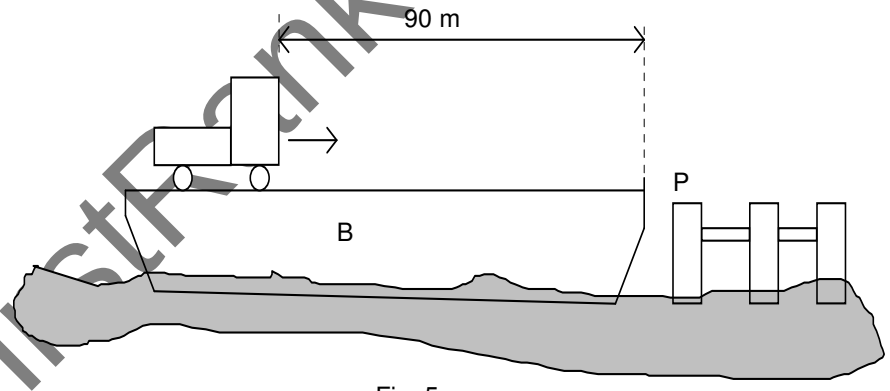

Fig. 5

6.(b) The rod shown in Fig. 6 is supported by two brackets at A and B. Determine the moment M_{AB} produced by the force F = (-500 $\boldsymbol{i}$ +200 $\boldsymbol{j}$ -300 $\boldsymbol{k}$) N, which tends to rotate the rod about the axis AB.

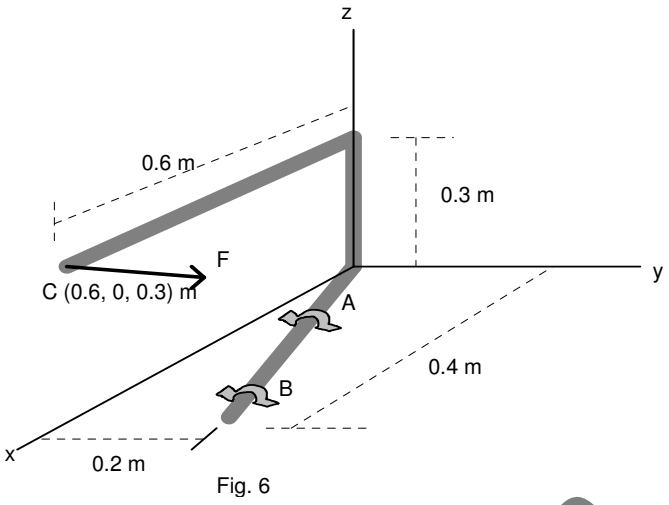

Fig. 6

[8+8]

7.(a) The 30 kg box has a speed of 2 m/s when it is at A on the smooth ramp shown in Fig. 7. If the surface is in the shape of a parabola, determine the normal force on the box at the instant x = 3. Also, what is the rate of increase in its speed at this instant?

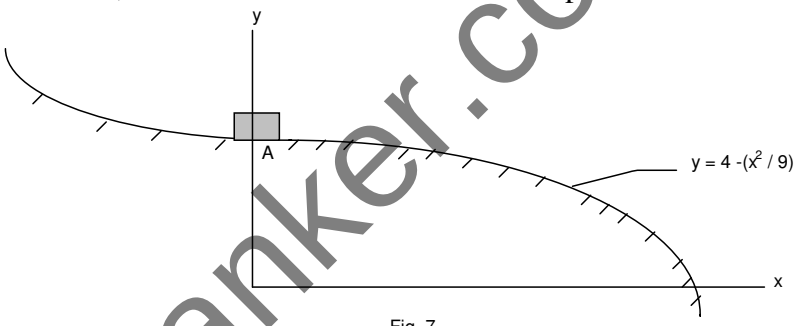

Fig. 7

(b) A pipe assembly is loaded as shown in Fig. 8. Replace the system of forces with a resultant force and couple moment at O, if the forces F1 and F2 are, respectively, are 60 N and 100 N. Express the results in cartesian vector form.

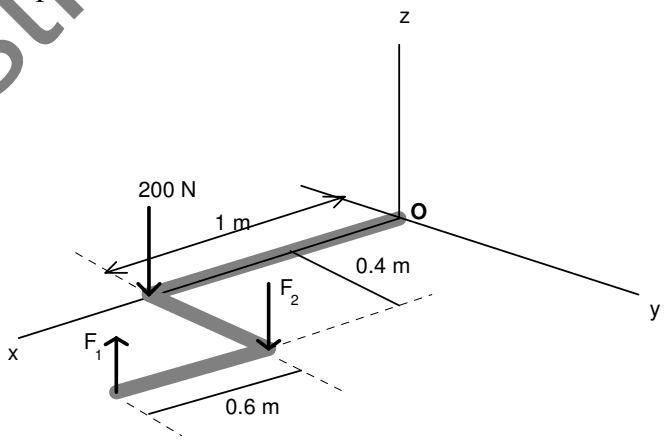

Fig. 8

[8+8]

Subject Code: R13210/R13 **Set No - 2**

I B. Tech II Semester Regular Examinations August - 2014

ENGINEERING MECHANICS

(Common to ECE, EEE, EIE, Bio-Tech, E Com.E, Agri. E)

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

Question Paper Consists of **Part-A** and **Part-B**
Answering the question in **Part-A** is Compulsory,
Three Questions should be answered from **Part-B**

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PART-A

1.(i) State coulomb's laws of dry friction.
(ii) State and prove the Theorem of Varignon.
(iii) Explain the how do you find the center of a system of parallel forces applies to different points in a plane.
(iv) Obtain the transfer formula for mass moments of inertia.
(v) Define normal and tangential of a particle and derive expressions for them.
(vi) State work-energy principle for plane motion of a rigid body.

[3+4+3+4+4+5+3]

PART-B

2.(a) The centre of mass of a front-wheel drive car is 35% of the wheel base behind the front wheels. Determine the load on the front and rear wheel tires. see Fig. 1.

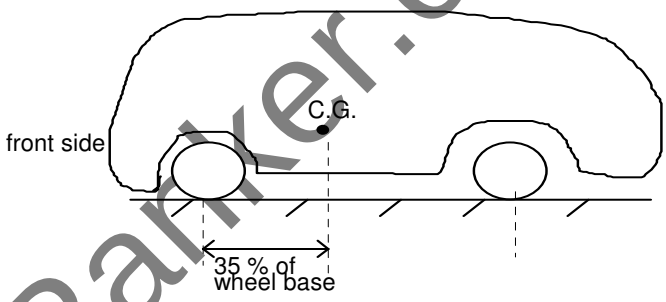

Fig. 1

(b) Determine the second moment of inertia about y-axis for the area shown in Fig. 2.

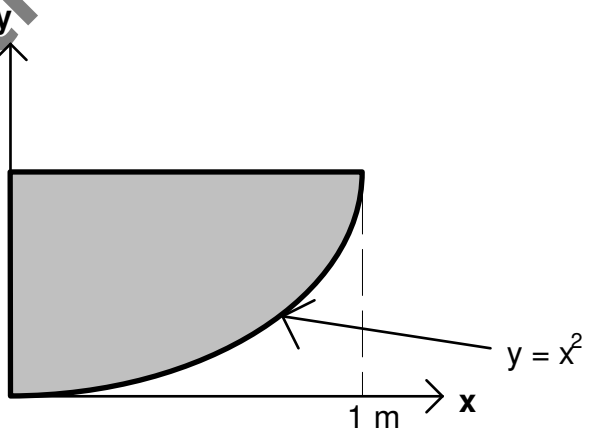

Fig. 2

[6+10]

3.(a) The collars hang on the vertical frame composed of two smooth rods. If the mass of collar A is 10 kg and the mass of collar B is 5 kg, determine the equilibrium angle α and the tension in the cable between the collars.

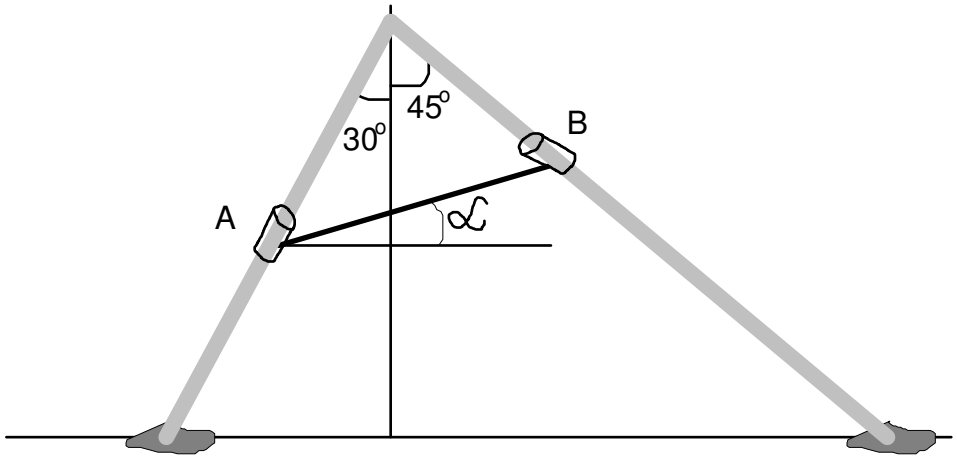

Fig. 3

(b) Calculate the centroid of the line y = sin(x) from the origin to the point $(\pi/2,1)$ mm.

[8+8]

4.(a) A crate of 100 kg mass shown in Fig. 4 is 3m tall and is loaded such that its centre of gravity is 2 m above its base of 1 m wide. Determine the force **P** required to initiate motion if, the coefficient of friction between the base and the inclined surface is 0.4. Also, determine the minimum and maximum height **h** where the force can be applied.

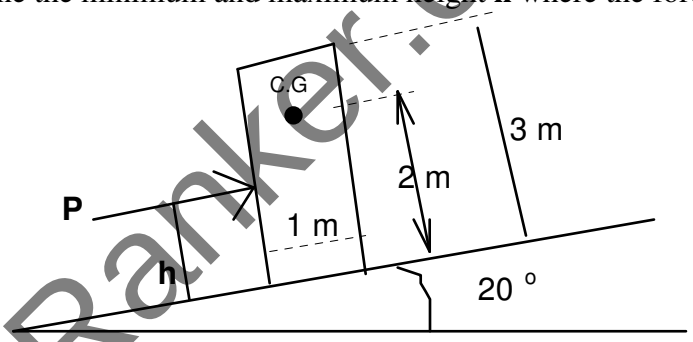

Fig. 4

(b) Locate the center of gravity of the homogeneous wire shown in Fig. 5.

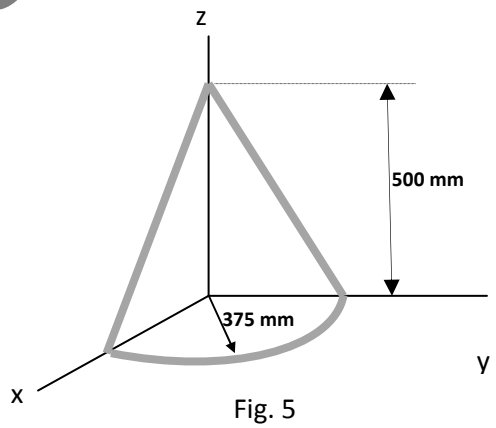

Fig. 5

[8+8]

5.(a) Determine the mass moment of inertia of the overhung crank shown in Fig. 6 about the x-axis. The density of the material is 7850 kg/m^3.

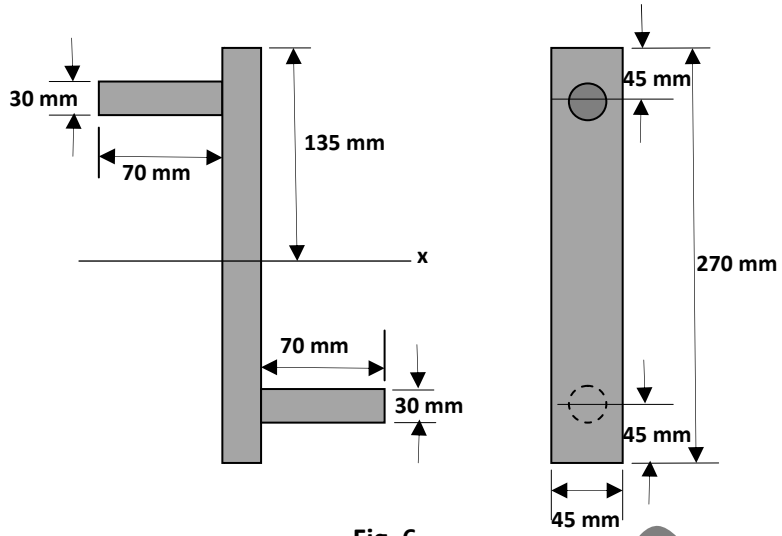

Fig. 6

(b) A block is released from rest at A and slides down the smooth circular surface AB as shown in Fig. 7. It then continues to slide along the horizontal rough surface until it strikes the spring. Determine how far it is compressed before stopping.

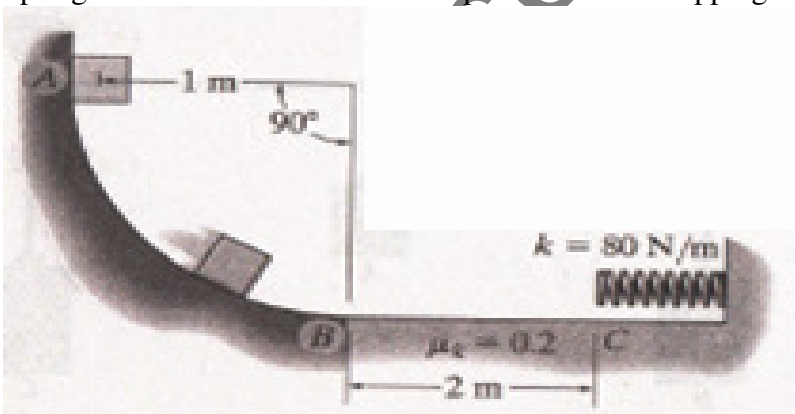

Fig. 7

[8+8]

6.(a) Determine the tension in the cables BD and CD and also the reaction force components at the ball and socket joint at A. See Fig. 8.

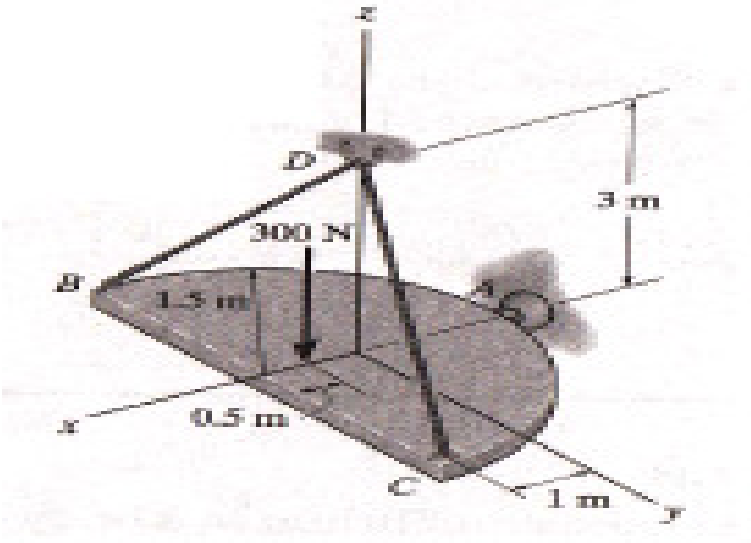

Fig. 8

(b) A block of 10 kg mass is held at rest on the smooth inclined plane by a stopper at A as shown in Fig. 9. If the 10 grams bullet travelling at 400 m/s gets embedded in the block, determine the distance the block will slide up along the plane before momentarily stopping.

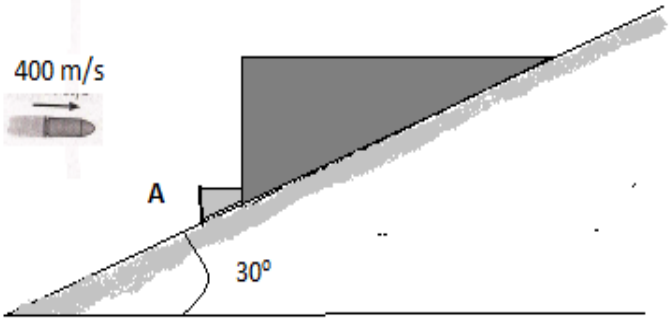

Fig. 9

[8+8]

7.(a) Determine the acceleration of the 500 kg block shown in Fig. 10 if the coefficient of friction between the block and the horizontal surface is 0.3. Also, find the reactions at the points A and B.

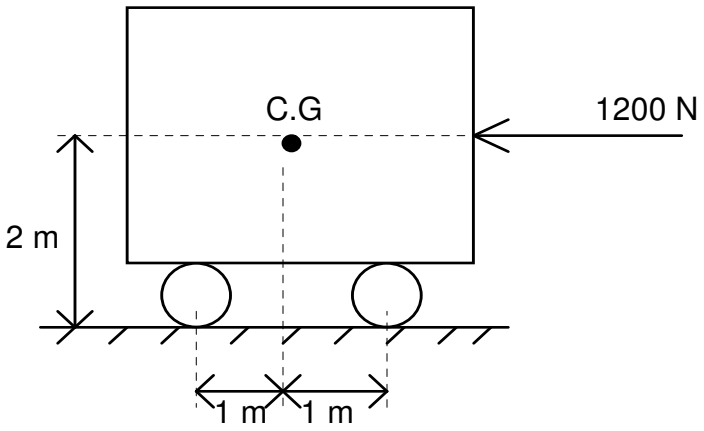

Fig. 10

(b) The unbalanced wheel shown in Fig. 11has a mass of 20 kg and a radius of gyration of 120 mm. Compute the normal and friction forces acting on the wheel at its point of contact with the horizontal surface, assuming that no slipping occurs.

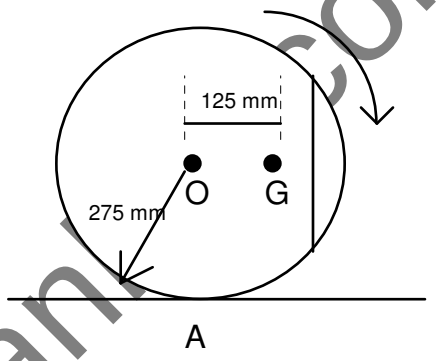

Fig. 11

[8+8]

Subject Code: R13210/R13 **Set No - 3**

I B. Tech II Semester Regular Examinations August - 2014

ENGINEERING MECHANICS

(Common to ECE, EEE, EIE, Bio-Tech, E Com.E, Agri. E)

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

Question Paper Consists of **Part-A** and **Part-B**
Answering the question in **Part-A** is Compulsory,
Three Questions should be answered from **Part-B**

*****

PART-A

1.(i) State equilibrium conditions for the system of coplanar non-concurrent forces and non-concurrent forces in space.

(ii) Differentiate between static friction and kinetic friction.

(iii) Determine the mass moment of inertia of an equilateral triangular plate of mass **M** and side **a** about one of its sides.

(iv) A car of 2 ton mass moving at a speed of 72 kmph is to be brought to a halt in a distance of 50 m. What should be the braking force applied assuming it to be uniform?

(v) Determine the workdone in stretching a spring to an elongation of x from its unstretched position.

(vi) A stone is vertically upwards from the top of a building with a velocity of 20 m/s. If it reaches the ground after 5 seconds, determine the height of the building.

(vii) State the principle of angular momentum.

[4+2+4+4+3+3+2]

PART-B

2.(a) Two identical smooth cylinders each of weight **W** and radius **r** are placed in a quarter circular cross-sectional channel of radius R as shown in Fig. 1, such that they just fit in the channel. Determine the reactions at the contact surfaces A, B, C and D.

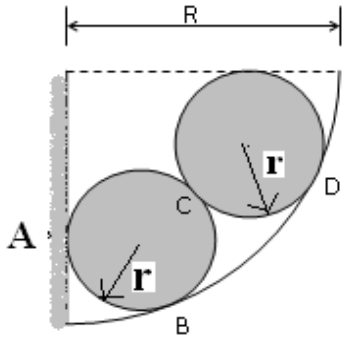

Fig. 1

2.(b) A smooth tube AB in the form of a quarter circle of mean radius **r** is fixed in a vertical plane and contains a flexible chain of length $\pi r/2$ as shown in Fig. 2. The weight of the chain is ***w*** per unit length.Find the velocity of the chain with which it will move along the smooth horizontal plane BC after it emerges from the tube.

Fig.2

[8+8]

3. A boom AD supporting a load of 20 kN at the end D is held in a horizontal position by a ball and socket joint at A and by two cables BE and CF as shown in Fig. 3. Determine the tension in each cable and the reaction at A, neglecting the weight of the boom.

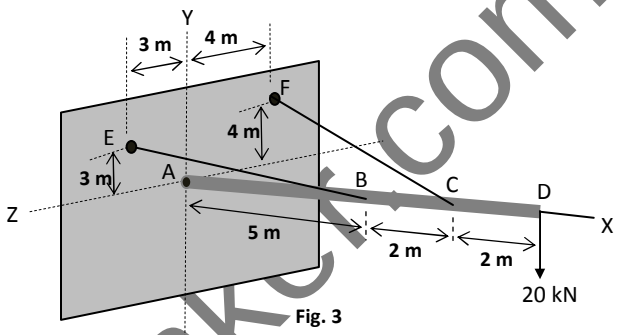

Fig. 3

[16]

4.(a) Find the centroid for the shaded area shown in Fig. 4.

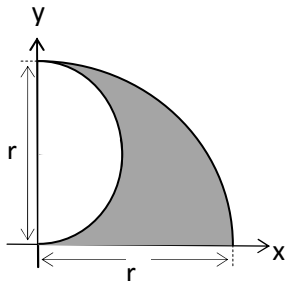

Fig. 4

4.(b) 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. The total mass of the rod is 12 kg. See Fig. 5.

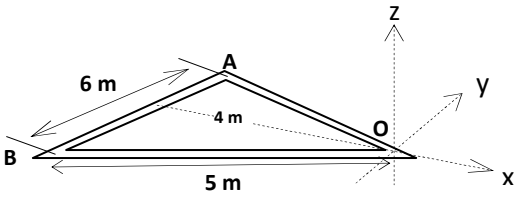

Fig. 5

[8+8]

5.(a) If the density of a hemisphere shown in Fig. 6 varies as the distance, y from the base plane, determine the distance of the center of gravity from the base plane.

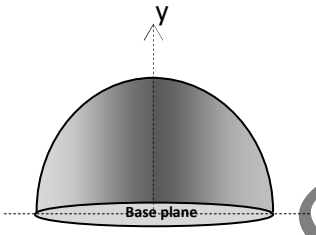

Fig. 6

(b) A block of mass m, initially at rest, begins to slide from the top most point of a hemispherical shell. Determine the position of the point on the hemisphere at which the block loses contact with the shell. See Fig. 7.

Fig.7

[8+8]

6.(a) A car of 2 ton mass powered by an engine of 50 kW capacity, start from rest and attains maximum speed in 30 seconds. If the frictional resistance to motion is 0.5 kN/ ton, determine the maximum speed it can attain. If after attaining the maximum speed, the engine is switched off, determine the distance it would travel before coming to rest.

(b) Determine the product of inertia for the quarter-circular area shown in Fig. 8 with respect to the given X and Y axes.

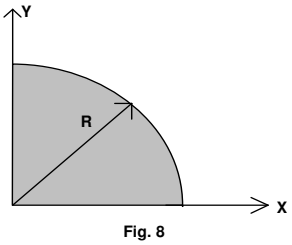

Fig. 8

[8+8]

7.(a) A man of 80 kg mass jumps on to a cart from a bridge such that he lands on with a velocity of 6 m/s at an angle of 30^o to the horizontal direction. If the cart is free to move, determine the velocity of the cart after he has jumped in when the cart is moving with a velocity of 2 m/s towards the bridge. The mass of the cart is 150 kg. Also, determine the loss in kinetic energy of the system. Fig. 9

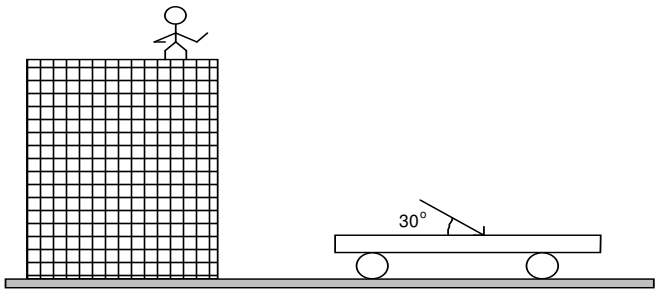

Fig. 9

(b) Block A of weight W rests on an inclined plane is prevented from moving downwards along the plane by a plank B of same of weight W placed as shown in Fig. 10. The plank is attached to the wall by the string CD parallel to the inclined plane. If the coefficient of friction is same for all contact surfaces, determine its value at which the motion is impending. Also, determine the tension in the string CD.

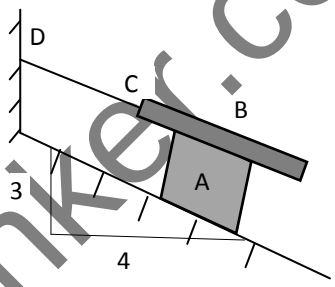

Fig. 10

[8+8]

Subject Code: R13210/R13 **Set No - 4**

I B. Tech II Semester Regular Examinations August - 2014

ENGINEERING MECHANICS

(Common to ECE, EEE, EIE, Bio-Tech, E Com.E, Agri. E)

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

Question Paper Consists of **Part-A** and **Part-B**
Answering the question in **Part-A** is Compulsory,
Three Questions should be answered from **Part-B**

*****

PART-A

1.(i) Show that the theorem of Varignon holds for parallel forces.

(ii) Write the equilibrium equations for a system of (a) couples in space (b) parallel forces in space.

(iii) Find the product of inertia of a rectangle of sides **a** and **b** with respect to the axes that lie along its two sides.

(iv) A particle of mass m moves rectilinearly under the action of a force $F = F_o \sin \omega t$. Determine the displacement-time equation, assuming initial displacement and velocity are zeros.

(v) The maximum range of a projectile is 2000 m. What should be the angle of elevation so as to obtain a range of 1400 m if the initial velocity remains unchanged?

(vi) Define instantaneous center of rotation.

(vii) Write the equations of plane motion of a rigid body.

[3+4+4+3+4+2+2]

PART-B

2.(a) A beam hinged at A is supported in a horizontal position by a rope passing over a pulley arrangement as shown in Fig. 1. The free end of the rope supports a load of 1500 N. The weight of the beam is 2 kN and that of pulley hinged at B is 400 N. Determine the tension in the rope, assuming the pulleys to be frictionless, and the reaction at A.

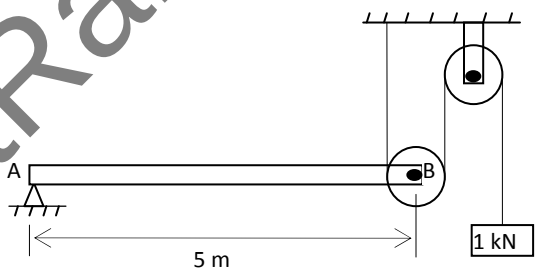

Fig. 1

(b) A cannon fires a bomb at an angle of 45 degrees to the horizontal ground with a release velocity of 150m/s. At the highest point of its trajectory, the bomb explodes into two pieces of equal mass. If one of the pieces just drops freely, determine the distance from the cannon at which the other piece strikes the ground.

[8+8]

3.(a) A force F of magnitude 300 N is directed from A (2, 3, 4) m to B (6, 5, 3) m. Determine (i) the moment of the force F about the point C(5,6, 7) and (ii) the moment of the force F about the axis passing through the origin and point C.

(b) A thin steel hoop of weight **W** and radius **r** starts from rest at A and rolls down on a cylindrical surface of radius **a** as shown in Fig. 2. Determine the angle θ defining the position of point B where the hoop will begin to slip if the coefficient of friction at the point of contact is 0.33.

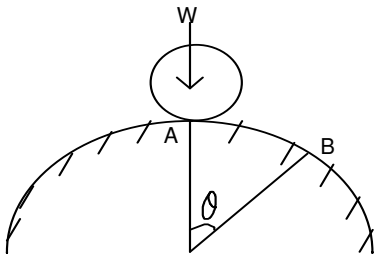

Fig. 2

[8+8]

4.(a) Find the reactions at the supports A and B of the beam that is loaded as shown in Fig. 3.

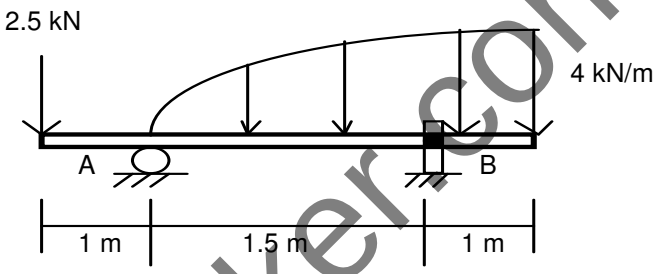

Fig. 3

(b) For the shaded area shown in Fig. 4, find the ratio a/b for which the x and y coordinates of the centroid are equal.

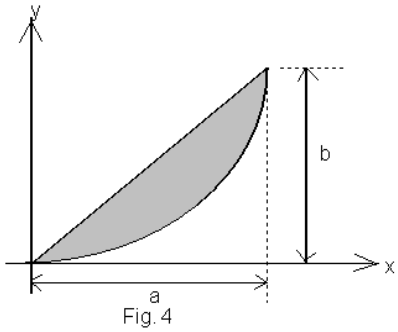

Fig. 4

[8+8]

5.(a) Determine the distance of the center of gravity of hemispherical thin shell of radius R from the plane of the base.

5.(b) Calculate the moment of inertia of the shaded area shown in Fig. 5 with respect to the x-axis.

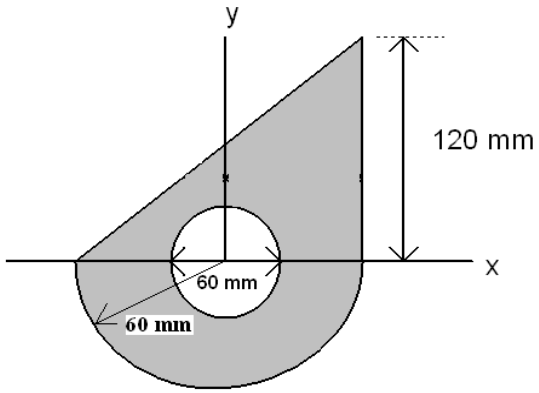

Fig. 5

[8+8]

6.(a) Determine the mass moment of inertia of a homogeneous sphere of radius **a** with respect to a diameter.

(b) A sphere of radius *r* and weight W is projected along a horizontal plane surface with initial linear velocity V_o and initial angular velocity ω_o such that $V_o > r\omega_o$. Determine the time elapsed for the velocity of the sphere along the plane to become constant. See Fig. 6.

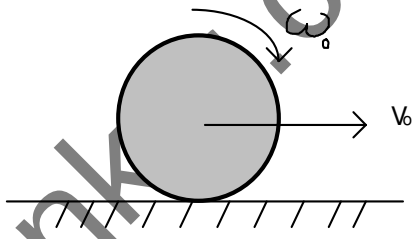

Fig. 6

[8+8]

7.(a) A small block of weight 50 N is given an initial velocity of 4 m/s down the inclined plane shown in Fig. 7. Determine the velocity of the block at B after it has travelled a distance of 12 m if, the coefficient of friction between the plane and the block is 0.2.

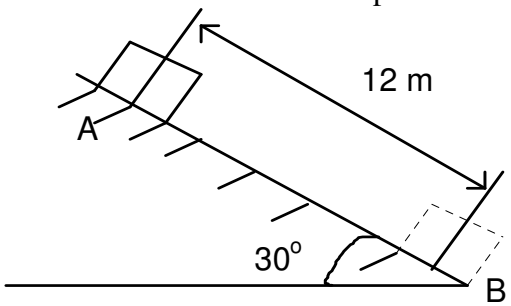

Fig. 7

7.(b) A horizontal beam is hinged to a vertical wall at A and supported at the midpoint C by a tie rod CD as shown in Fig. 8. Find the tension in the rod and the reaction at A due to a vertical load P = 2 kN applied at B. Neglect the weight of the beam and tie rod.

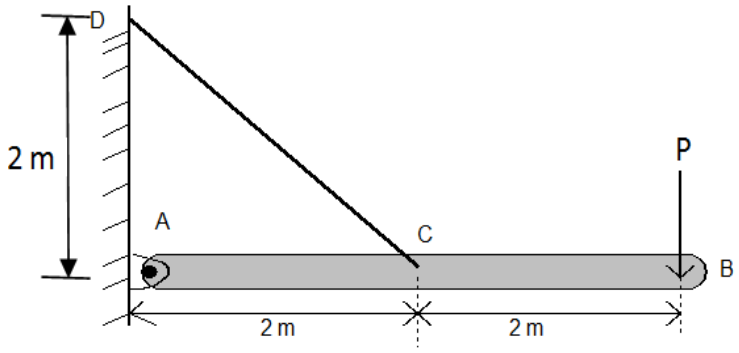

Fig. 8

[8+8]