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

II B. Tech I Semester Supplementary Examinations, Jan - 2015
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) What is meant by moment of force? How will you explain it mathematically? Also explain clearly the differences between clockwise and anticlockwise moments.
   b) State the characteristics of a couple? (10M+5M)

2. A lamp weighing 10N is suspended from the ceiling by a chain. It is pulled aside by a horizontal cord until the chain makes an angle of 60^0 with the ceiling. Find the tensions in the chain and the cord by applying Lami's theorem and also by graphical method? (15M).

3. a) Define 'Center of gravity'? Find the center of gravity of the T – Section as shown in the Figure 3a. All dimensions in cm.
   b) Determine the centroid of the area shown in the figure 3b with respect to the axes shown. (7M+8M)

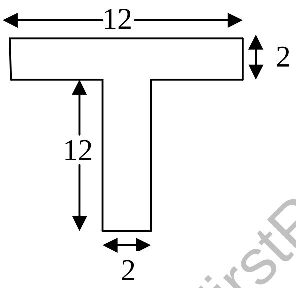

Figure 3a

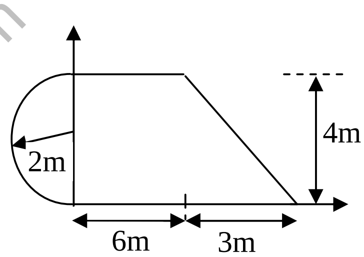

Figure 3b

4. Find the moment of inertia of a hollow section shown in Figure 4 about an axis passing through its center of gravity or parallel to X –X axis. All dimensions in mm. Diameter of the hallow circle is 150 mm. (15M)

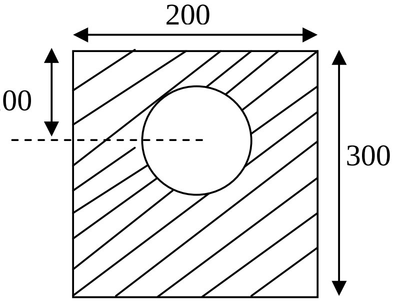

Figure 4
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5. a) Describe the procedure for drawing the vector diagram of a truss subjected to horizontal loads.

b) Determine the forces in the various members of the truss as shown in the figure 5b. State whether they are compressive or tensile. (5M+10M)

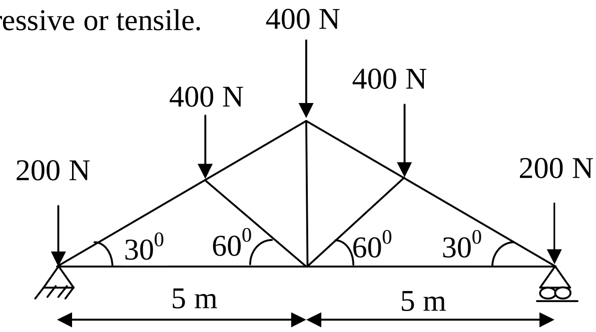

Figure 5b

6. a) On a straight road a smuggler's car passes a police station with a uniform velocity of 10m/sec. After 10 sec a police party follows in pursuit in a jeep with a uniform acceleration of $1m/sec^2$. Find the time necessary for the jeep to catch up the smuggler's car?

b) Define mass moment of inertia and kinetic energy of rotation? Derive a relation between torque and angular acceleration of a body rotating about an axis? (8M+7M)

7. a) A spring is used to stop a 1000N package which is moving down a 20^0 incline. The spring has a constant K = 150N/mm and is held by the cables so that it is initially compressed by 100mm. If the velocity of the package is 6m/sec, when it is 10m from the spring. Determine the maximum additional deformation of the spring in bringing the package to rest? Take coefficient of friction 0.25?

b) A man weighing 750N and a boy weighing 500N jump from a boat to a pier with a horizontal velocity of 5m/sec relative to the boat. The boat weighs 4000N and was stationary before they jumped. Determine the velocity of the boat if (i) they jump together. (ii) Boy jumps first and the man later. (iii) Man jumps first and boy later. (7M+8M)

8. a) Prove that angle of friction is equal to the angle of inclined plane when a solid body of weight 'W' placed on the inclined plane is about to slide down?

b) A uniform ladder of length 13m and weighing 30N is placed against a smooth vertical wall with its lower end 10m from the wall. In this position the ladder is just to slip. Determine: i) The coefficient of friction between ladder and the floor. ii) Frictional force acting on the ladder at the point of contact between ladder and floor? (7M+8M)

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1. a) Define the term 'force'? What are the characteristics of a force? Explain clearly the procedure for finding out the resultant force analytically as well as graphically?
   b) Four forces of magnitudes 10N, 20N, 30N, 40N are acting respectively along four sides of a square (length of each side is 1 m) as shown in **Figure 1a**? Determine the magnitude, direction and position of the resultant force? (7M+8M)

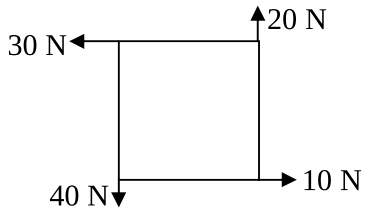

Figure 1a

2. a) A weight of 900N is supported by two chains of length 4m and 3m as shown in Figure 2a. Determine tension in each chain using Lami's theorm?
   b) Define the following terms
   i) Resultant ii) Equilibrant iii) Equilibrium iv) Free body (11M+4M)

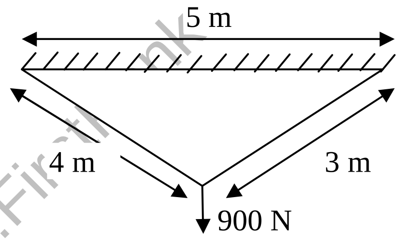

Figure 2a

3. a) Distinguish the center of gravity and centroid? Find the center of gravity of a T-section with flange 150×10 mm and web 150×10 mm?
   b) Find centroid of the unequal angle 200×150×12 mm shown in **Fig 3b**. All dimensions in mm. (7M+8M)

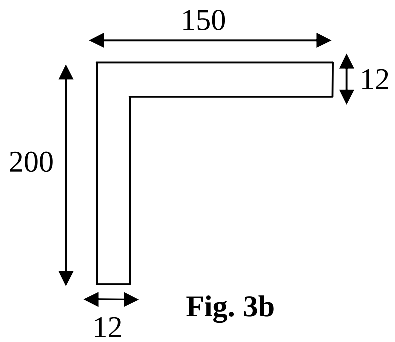

Fig. 3b
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Code No: R21031 **R10** SET - 2

4. Find the moment of inertia of the section shown in the **Figure 4** about centroid axis X-X perpendicular to the web. All dimensions in cm. (15M)

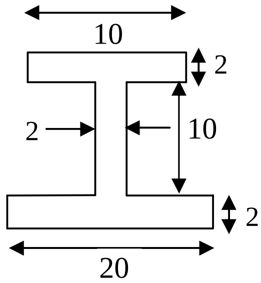

Figure 4

5. a) Describe the step-by-step procedure of method of joints in the analysis of perfect truss?
   b) Determine the forces in the various members of a pin jointed truss as shown in Figure 5b. Tabulate the result stating whether they are in tension or compression. (5M+10M)

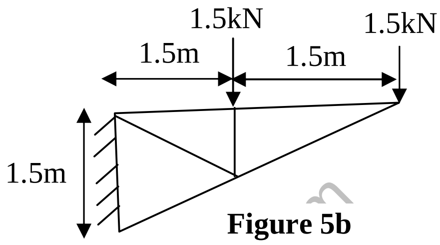

Figure 5b

6. a) A car is moving with a velocity of 15m/sec. The car is bought to rest by applying brakes in 5sec. Determine (i) retardation (ii) distance travelled by the car after applying brakes?
   b) A solid uniformly thick wheel of radius 1m and mass 40kg is released with no initial velocity at the top of an inclined plane which makes an angle of 30^0 with the horizontal. It rolls down without slipping. Determine (i) the minimum value of coefficient of friction (ii) velocity of the center of the wheel after it has travelled a distance 4m down the inclined plane? (7M+8M)

7. a) A 10000 kN train is accelerated at a constant rate up a 2% grade. The track resistance is constant at 9 N/kN. The velocity increases from 9m/sec to 18m/sec in a distance of 600m. Determine maximum power developed by the locomotive.
   b) A 20 kN automobile is moving at a speed of 70kmph. When the brakes are fully applied causing all the four wheels to skid. Determine the time required to stop the automobile i) On concrete road for which $\mu = 0.75$. ii) On ice for which $\mu = 0.08$. (7M+8M)

8. a) What do you understand by the term 'friction'? Explain clearly why it comes into play? State the laws of friction?
   b) A uniform ladder of weight 800N and of length 7m 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? (7M+8M)

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

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1. a) Three forces 2P, 3P, 4P act along the three sides of an equilateral triangle of side 100mm taken in order. Find the magnitude and position of the resultant force.

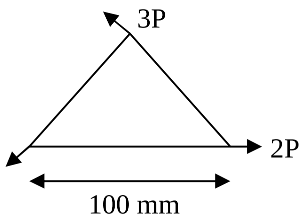

Figure 1a

b) Discuss the classification of couples and explain clearly the differences between a positive couple and negative couple? (8M+7M)

2. State and explain the following:
i) Parallelogram law ii) Triangle law iii) Lami's theorem (15M)

3. a) Describe various methods of finding out the center of gravity of a body? Find the center of gravity of an inverted T – section with flange 60 × 10 mm and web 50 × 10 mm?
b) Locate the centroid of the I – section shown in Figure 3. All dimensions in mm? (7M+8M)

4. Determine polar moment of inertia about X –X and Y –Y axis of the I –section shown in Figure 4. All dimensions are in mm. (15M)

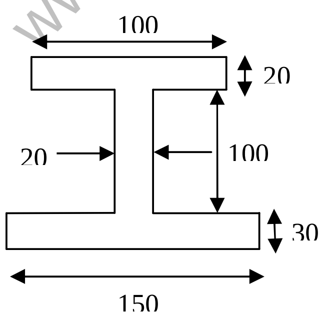

Figure 3

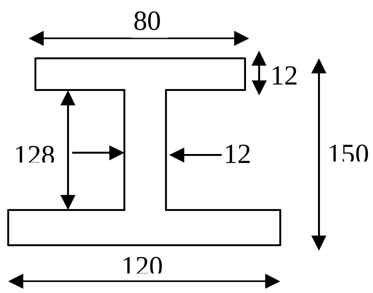

Figure 4
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Code No: R21031 **R10** SET - 3

5. a) State and explain the polygon law of forces with neat sketch?
   b) Figure 5b shows a warren girder consisting of seven members each of 3m length freely supported at its end points. The girder is loaded at B, C as shown. Find the forces in all the members of the girder indicating whether the force is compressive or tensile. Solve using method of joints and method of sections. (5M+10M)

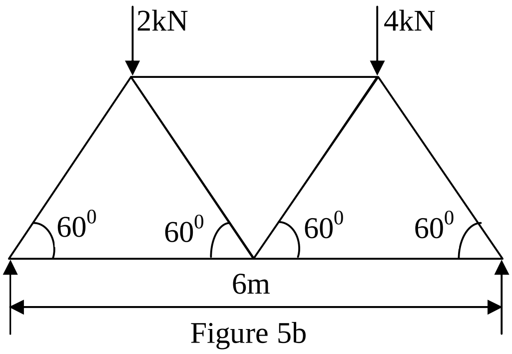

Figure 5b

6. a) A bullet moving at the rate of 250 m/sec is fired into a log of wood. The bullet penetrates to a depth of 40 cm. if the bullet moving with the same velocity is fired into similar piece of wood 20 cm thick, with what velocity would it emerge? Take the resistance to be uniform in both the cases.
   b) Two bodies A and B of masses 800 kg and 600 kg are attached at the ends of a flexible rope. The rope passes over a pulley of 800 mm diameter. The pulley has a mass of 100 kg with a radius of gyration as 400 mm about its axis of rotation. Find the torque which must be applied to the pulley to raise the 800 kg body with acceleration of 1 m/sec^2. Neglect friction of spindle (7M+8M)

7. a) Find the power required to pull a train up an incline of 1 in 200 at a speed of 36kmph, if the weight of the train is 3000kN and the track resistance is 5 N/kN. Also determine the maximum speed with which the train moves up on incline of 1 in 100 with the same power.
   b) A block weighing 200 N is pulled up a 30^0 plane by a force P producing a velocity of 5 m/s in 5 s. If μ = 0.2, determine the magnitude of force P. At this stage if force P is removed how much more. Time it will take to come to rest? (7M+8M)

8. a) State and explain (i) The laws of static and dynamic friction. (ii) The laws of solid friction?
   b) A uniform ladder of weight 250 N and of length 5 m rests on a horizontal ground and leans against a rough vertical wall. The coefficient of friction between the ladder and the floor is 0.3 and between the ladder and vertical wall is 0.2. When a weight of 900 N is placed on the ladder at a distance of 2 m from the top of ladder. The ladder is at the point of sliding. Find
   i) The angle made by the ladder with horizontal.
   ii) Reaction at the foot of the ladder
   iii) Reaction at the top of the ladder. (7M+8M)

Code No: R21031 **R10** SET - 4

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1. a) State and explain Varigon principle of moments?
   b) Three forces equal to 3P, 5P and 7P act simultaneously along the three sides AB, BC, CA of an equilateral triangle ABC of side 'a'. Find the magnitude, direction and position of the resultant? (10M+5M)

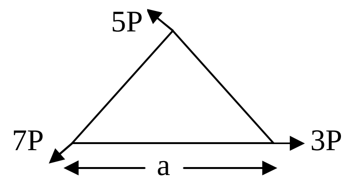

Figure 1b

2. a) A ball of weight 120 N rests in a right angled groove as shown in Figure 2a. The sides of the groove are Inclined to an angle of 30^0 and 60^0 to the horizontal. If all the surfaces are smooth then determine the reactions R_A and R_C at the points of contact?
   b) Explain the term 'free body diagram'? Draw the free body diagram of a ball of weight 'W' placed on horizontal surface? (10M+5M)

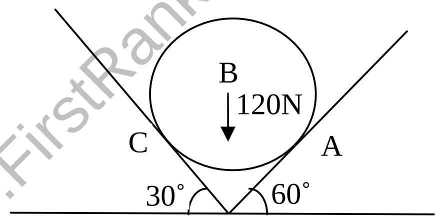

Figure 2a

3. a) Determine the expression for center of gravity of a plane area using the method of moments.
   b) Find the centroid of an unequal angle section 100 × 80 × 20 mm shown in figure 3?

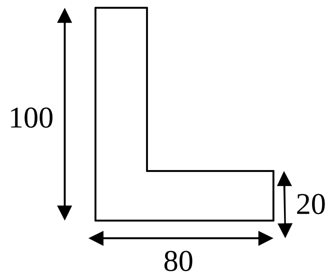

Figure 3
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4. Find the moment of inertia of a T – section with flange 150 × 50 mm and web 150 × 50 mm about X –X and Y – Y axes through the centroid of the section? (15M)

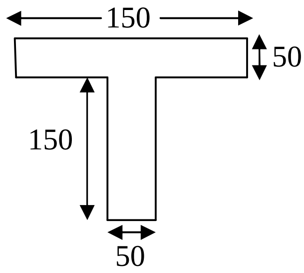

Figure 4

5. a) What is cantilever truss? How will you find out its support reactions?
   b) A truss of 8m span is loaded as shown in Figure 5b. Find the forces in the members CD, FD and FE of the truss? (5M+10M)

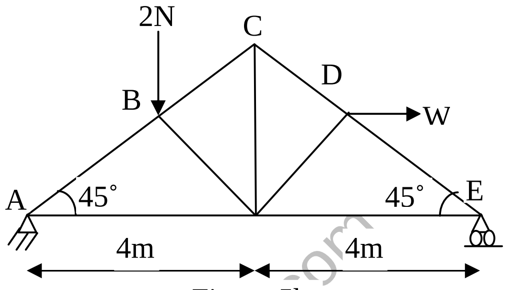

Figure 5b

6. a) A car had a start with an acceleration of 2 m/s^2. A police vigilant party came after 10s and continued to chase the car with a uniform velocity of 40 m/s. Find the time taken in which the police van will Overtake the car.
   b) A flywheel with a radius of gyration 0.9m is fitted to a multi cylinder engine, which runs at a mean speed of 360 rpm. If the speed varies from 2 % above mean to 2% below it and the fluctuation energy is 30 kN-m, find (i) moment of inertia of the wheel and (ii) mass of the flywheel. (5M+10M)

7. a) A mine cage weighs 12 kN and can carry a maximum load of 20 kN. The average frictional resistance of the side guys is 500N. What constant cable tension is required to give a loaded cage an upward velocity of 3m/sec from rest in a distance of 3m?
   b) An engine of weight 500 kN pulls a train weighing 1500 kN up on incline of 1 in 100. The train starts from rest and moves with a constant acceleration against a resistance of 5N/kN. It attains a speed of 18 kmph in 60 sec. Determine the tension in the draw bar connecting train and the engine? What will be its speed 90sec after the start? (7M+8M)

8. a) What do you mean by 'angle of response'? Prove that angle of response is equal to the angle of friction? (7M+8M)
   b) A uniform ladder of length 10m and weighing 20N placed against a smooth vertical wall with its lower end 6m from the wall. The coefficient of friction between the ladder and the floor is 0.45. Show that the ladder will remain in equilibrium in this position. What is the frictional force acting on the ladder at the point of contact between the ladder and floor?