Ref. No: Ex/Prod/T/111/2017(S)

B. PROD. ENGG. 1ST YEAR 1ST SEM. SUPPLEMENTARY EXAMINATION-2017

ENGINEERING MECHANICS

Time : Three hours **Full Marks : 100**

ANSWER ANY TEN QUESTIONS

1. A force, $\mathbf{F} = 80\mathbf{i} + 50\mathbf{j} - 15\mathbf{k}$ N goes through a point having position vector, $\mathbf{r} = 5\mathbf{i} - \mathbf{j} + 4\mathbf{k}$ m relative to a coordinate system. Compute the moment of the force about an axis going through points A and B, having respective position vectors : 10

   $\mathbf{r}_A = 2\mathbf{i} + \mathbf{j} - 0.6\mathbf{k}$ m, and $\mathbf{r}_B = \mathbf{i} - \mathbf{j} + 4\mathbf{k}$ m.

2. A smooth right circular cylinder of radius r rests on a horizontal plane and is kept from rolling by an inclined string AC of length $2r$, as in fig. 2. A prismatic bar AB of length $3r$ and weight **Q**, hinged at point A, leans against the roller as shown. Find the tension induced in the string AC. 10

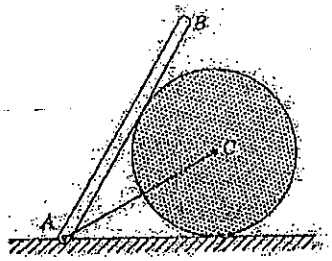

Fig. 2

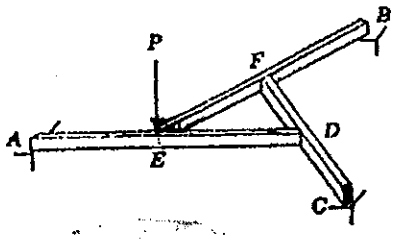

Fig. 3

3. Three identical bars of, each of length l, are nailed together at their mid-points to form a triangular frame which is supported in a horizontal plane as in fig. 3. Find the magnitudes of the reactions at A, B and C, if a vertical load **P** is applied at E as shown. Neglect weight of the bars. 10

4. What horizontal force **P** is necessary to apply to the wedge of negligible weight to raise the stone block of weight 2000 kgf of fig. 4. The coefficient of static friction for all surfaces is 0.25. 10

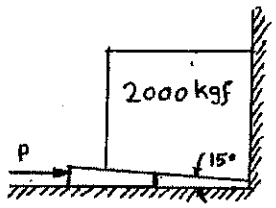

Fig. 4

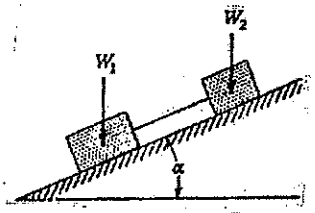

Fig. 5

5. Two blocks of weights $\mathbf{W_1}$ and $\mathbf{W_2}$ rest on a rough inclined plane, and are connected by a short piece of string as shown in fig. 5. If the coefficients of friction are 0.2 and 0.3 respectively for the two blocks, find the maximum angle of inclination of the plane, so that the blocks will not slide. Assume $\mathbf{W_1} = \mathbf{W_2} = 5$ kgf. 10

6. Locate the centroid of the shaded area of fig. 6 with respect to the coordinate axes X and Y. 10

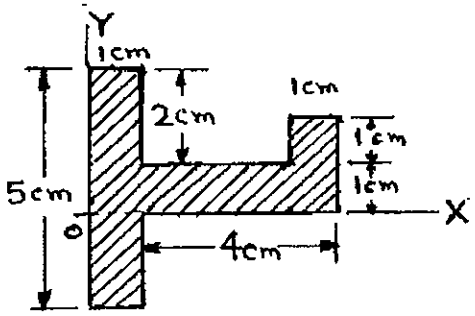

Fig. 6

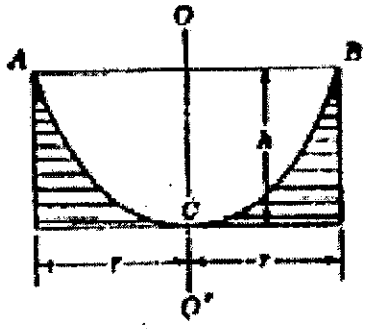

Fig. 7

7. A right circular cylindrical tank containing water spins about its vertical axis OO' at such speed that the free water surface is a paraboloid as shown in fig. 7. Find the volume of water in the tank, using the second theorem of Pappus. 10

8. Calculate the moments of inertia of the shaded area of fig. 8 with respect to x-axis, and the centroidal axis parallel to x-axis. 10

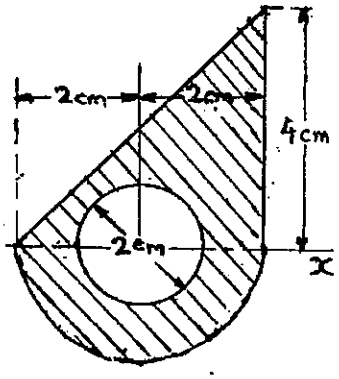

Fig. 8

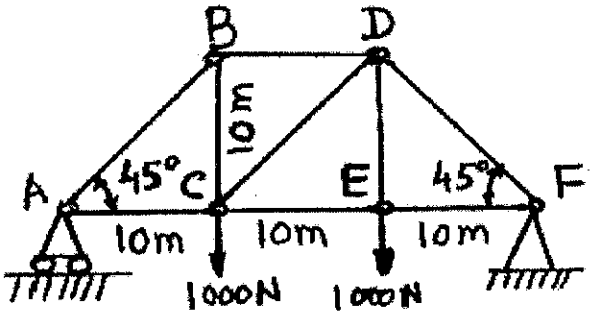

Fig. 9

9. A simple plane truss is shown in fig. 9. Two 1000 N loads are acting on pins C and E. Determine the forces transmitted in each member using the method of joints. Neglect the weight of the members. 10

10. Using the method of sections, determine the axial forces in the members CE, DE and DF of the tower (plane truss) due to a horizontal force **P** at A, as shown in fig. 10. Neglect weight of the members. 10

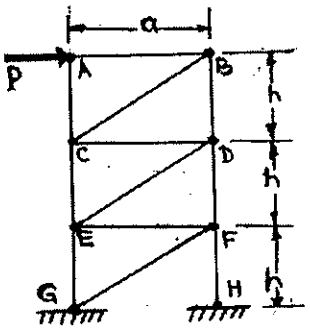

Fig. 10

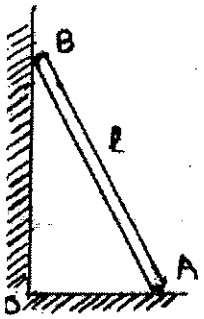

Fig. 11

11. A slender bar AB of length, l (remaining always in the same vertical plane) has its ends A and B constrained to remain in contact with a horizontal floor and a vertical wall, respectively, as in fig. 11. The bar starts from a vertical position, and the end A is moved along the floor with constant velocity, v. Determine the velocity-time and acceleration-time equations for the vertical motion of the end B of the bar. 10

12. The position coordinate of a particle moving rectilinearly, is given by, $x = 2t^3 - 24t + 6$, where x is in metre from a convenient origin and t is in sec. Determine (a) the time required for the particle to reach a velocity v of 72 m/s from its initial condition at $t = 0$, (b) the acceleration of the particle when $v = 30$ m/s , and (c) the net displacement of the particle during the interval from $t = 1$s to $t = 4$s. 10

13. A particle at position (3, 4, 6) m at time $t = 0$ sec is given a constant acceleration as $6\mathbf{i} + 3\mathbf{j}$ m/sec^2. If the velocity at the same time is $16\mathbf{i} + 20\mathbf{j} + 5\mathbf{k}$ m/sec, what is the velocity and position of the particle at $t = 20$ sec? 10

14. A car enters a section of curved road in the horizontal plane and slows down at a uniform rate from a speed of 100 km/hr at A to a speed of 50 km/hr at C as in fig. 14. The radius of curvature ρ of the road at A is 400 m and at C is 80 m. Determine the total horizontal acceleration of the car at positions A, B and C. Point B is the point where the curvature changes direction. 10

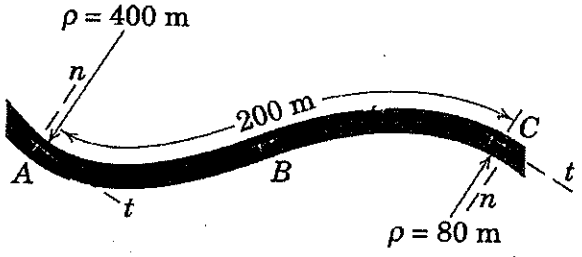

Fig. 14

15. Two blocks A and B slide down the inclined plane under the action of gravity, as in fig. 15. If the weights of the blocks are W_A = 5 kgf and W_B = 10 kgf, and the coefficients of kinetic friction between them and the inclined plane are μ_A = 0.15 and μ_B = 0.30, find the force existing the blocks during the motion. 10

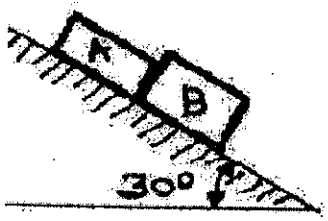

Fig. 15

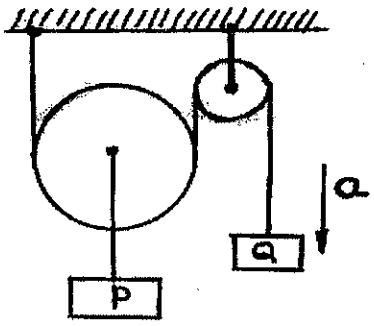

Fig. 16

16. Two weights **P** and **Q** are connected by the arrangement as shown in fig. 16. Neglecting friction and inertia of the pulleys and cord, find the acceleration of the weight **Q** using D'Alembert's principle. Assume **P** = 20 kgf and **Q** = 15 kgf. 10