B. E. PRODUCTION ENGG. 1ST YEAR 1ST SEMESTER EXAMINATION (Old) - 2019

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 :
$\mathbf{r}_A = 2\mathbf{i} + \mathbf{j} - 0.6\mathbf{k}$ m, and $\mathbf{r}_B = \mathbf{i} - \mathbf{j} + 4\mathbf{k}$ m. 10

2. Cylinders A and B have a mass of 200 kg each, and cylinder C has a mass of 400 kg in fig. 2. Compute all contact forces. 10

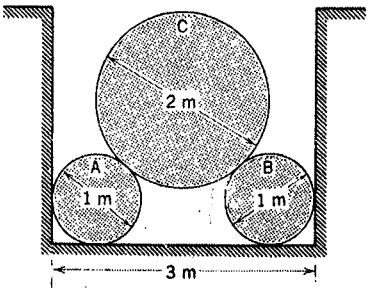

Fig. 2

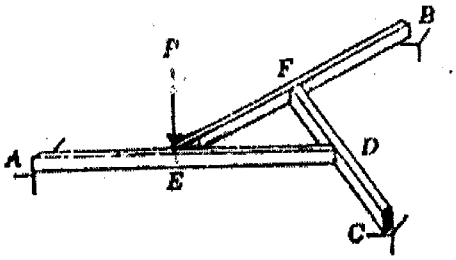

Fig. 3

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

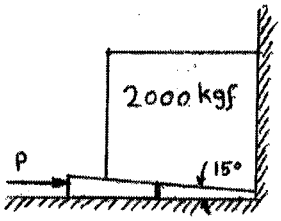

Fig. 4

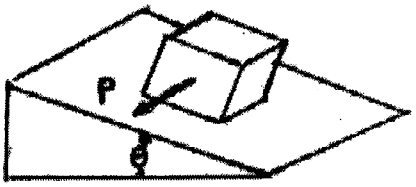

Fig. 5

5. A uniform rectangular block of weight **W** is at rest on a plane inclined at angle θ with the horizontal. If μ be the coefficient of friction between the block and the inclined plane, determine the magnitude of the maximum horizontal force **P**, which can be applied to the centre of the block, and acting in a plane parallel to the inclined plane as shown in fig. 5 before slipping begins. 10

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

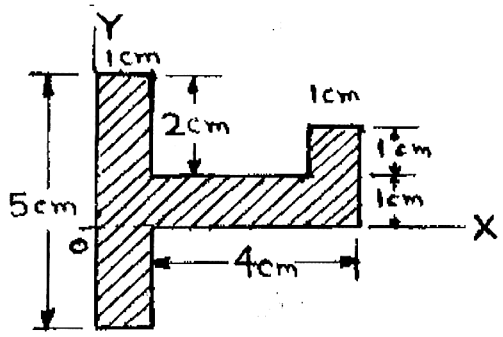

Fig. 6

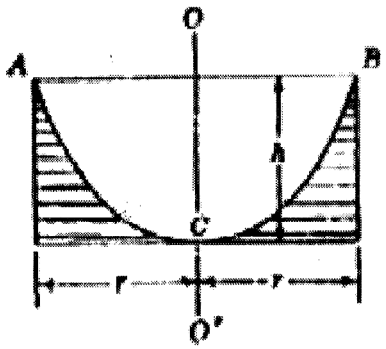

Fig. 7

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. Using the method of joints, determine the forces produced in all the members of the tower (plane truss) due to a horizontal force **P** applied at the top as shown in fig. 8. Neglect weight of the members. 10

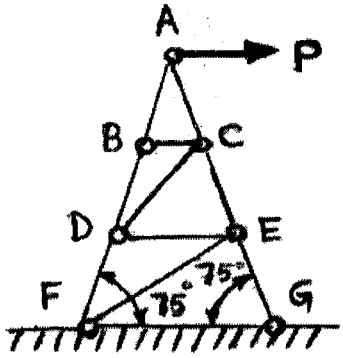

Fig. 8

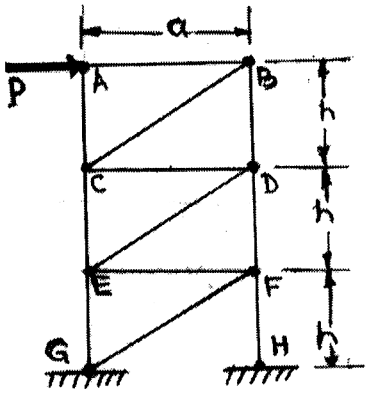

Fig. 9

9. 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. 9. Neglect weight of the members. 10

10. The greatest possible acceleration or deceleration that a train may have is a, and its maximum speed is v. Find the minimum time in which the train can get from one station to the next if the total distance is s. 10

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

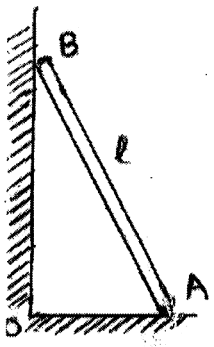

Fig. 11

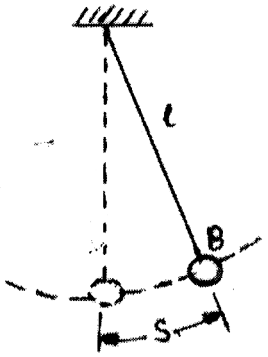

Fig. 12

12. Small oscillations of a simple pendulum of length, l, as in fig. 12, are represented by the displacement-time equation, $s = s_0 \cos(\omega t)$, where s_0 is the amplitude of swing and $\omega = \sqrt{(g/l)}$ is a constant. Find the maximum velocity and the maximum tangential and normal accelerations of the bob. 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. If the coefficient of friction between the 20-kg block A and the 100-kg cart B, as shown in fig. 14, is 0.5, determine the acceleration of each part (A & B) for **P** = 60 N. The cart B is free to roll, and the friction and weight of the pulley is negligible. 10

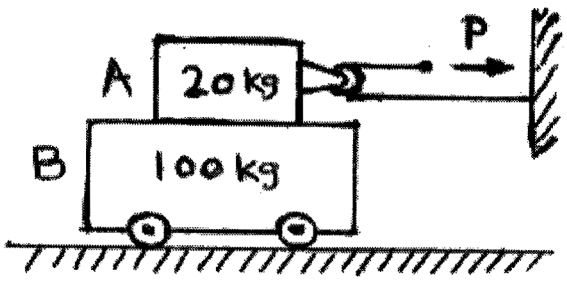

Fig. 14

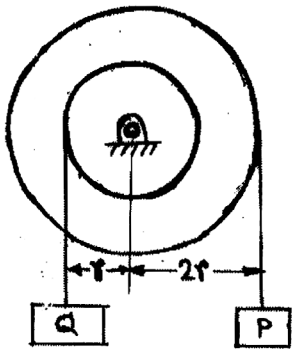

Fig. 15

15. Neglecting friction and inertia of the two-step pulley shown in fig. 15, find the acceleration of the falling weight P. Assume P = 4 kgf, Q = 6 kgf. 10