

| Exam.     | Regular/Back  |            |        |
|-----------|---------------|------------|--------|
|           | BE            | Full Marks | 80     |
| Level     | BEL, BEX, BCT | Pass Marks | 32     |
| Programme | I / I         | Time       | 3 hrs. |

**Subject: - Applied Mechanics**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. a) State the Varignon's theorem and also prove that a couple is a free vector. [4]
- b) Draw bending moment diagram, shear force diagram and axial force diagram for the frame shown in Figure No. 1. [12]

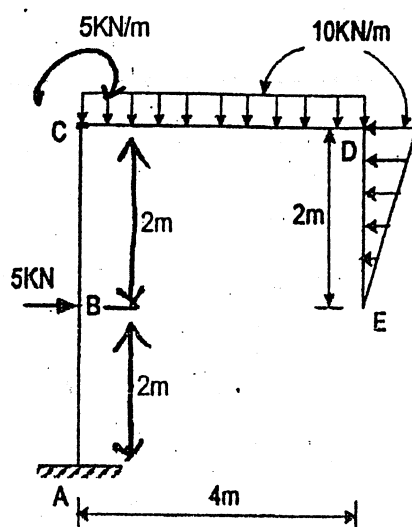


Figure no.1

2. a) Find the magnitude and direction of the resultant forces and moment of the following system about the point 'O' as shown in Figure No. 2. [8]

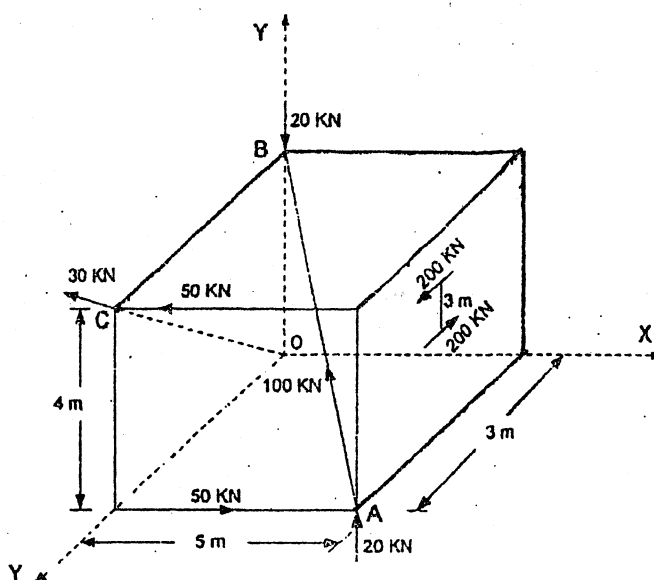


Figure no.2

- b) Determine the member forces in the pin jointed truss shown in Figure No. 3. [8]

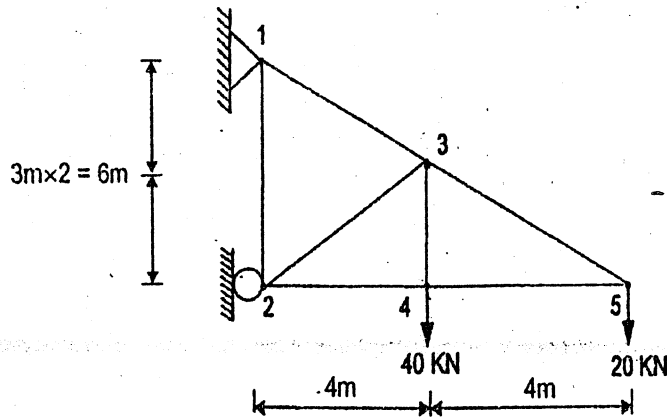


Figure no. 3

3. a) Prove that centre of pressure is always below the centroid of vertical plane surface submerged in the liquid. [6]  
 b) Determine the moment of inertia and radius of gyration of the shaded area as shown in Figure No. 4 about X and Y axes. [10]

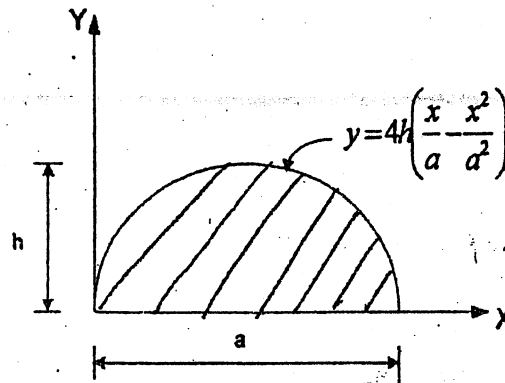


Figure no. 4

4. a) A ball is thrown vertically upward from the 12-m level in an elevator shaft with an initial velocity of 18 m/sec. At the same instant an open-platform elevator passes the 5-m level, moving upward with a constant velocity of 2 m/sec. Determine (i) when and where ball will hit the elevator, (ii) the relative velocity of ball with respect to the elevator when ball hits the elevator. [8]  
 b) The rectangular component of acceleration for particle are  $a_x = 3t$  and  $a_y = 10t$ , where,  $a$  is in  $\text{m/sec}^2$ . If the particle starts from rest at the origin, find the radius of curvature of the path at the instant of 2 sec. [8]  
 5. a) The balls 'A' and 'B' having same masses are coming from opposite direction forming an oblique central impact along horizontal plane surface (line of impact along x-axis). The velocities and direction of balls are 40 m/sec,  $60^\circ$  and 30 m/sec,  $30^\circ$  to x-axis respectively. Assuming  $e = 0.9$ , determine the magnitude and direction of the velocity of each ball after the impact. [10]  
 b) Show that the rate of change of angular momentum of the particle about any point is equal to the sum of the moments about the same points of the forces acting on the particle. [6]  
 6. a) State D'Alembert's Principle; also derive the equation of angular momentum of a rigid body in plane motion. [4]  
 b) A sphere of radius 'r' and mass 'm' is released with no initial velocity on the incline surface and rolls down without slipping. Determine (i) the minimum value of the coefficient of static friction compatible with the rolling motion, (ii) the velocity of the mass center of the sphere after the sphere has rolled 4m, (iii) the velocity of mass centre if the sphere were to move 4m down a frictionless  $30^\circ$  incline. [12]