

- ✓1. Force $F_1 = -16i + 10j - 5k$ N acts at the origin while $F_2 = -F_1$ acts at the end of a rod of length 12 m protruding (Figure 1) from the origin with direction cosines (0.6, 0.8, 0). What is the moment about point P at $r_p = 3i + 10j + 15k$ m? What is the moment about an axis going through P and having the unit vector $= 0.2i + 0.8j + 0.566k$? [4]

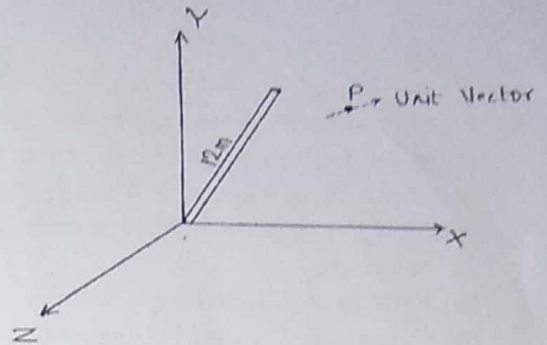


Figure 1

- ✓2. A submarine is moving in a translatory manner with the following velocity and acceleration relative to an inertial reference (Figure 2)

$$V = 6i + 7.5j + 2k \text{ m/s}$$

$$a = 0.2i - 0.24j + 0.52k \text{ m/s}^2$$

A device inside the submarine consists of an arm and a mass at the end of the arm. At the instant of interest, the arm is rotating in a vertical plane with the following angular speed and angular acceleration:

$\omega = 10 \text{ rad/s}$, $\dot{\omega} = 3 \text{ rad/s}^2$. The arm is vertical at this instant. The mass at the end of the rod may be considered to be a particle having a mass of 5 kg. What are the velocity and acceleration vectors for the motion of particle at this instant relative to the inertial reference?

[5]

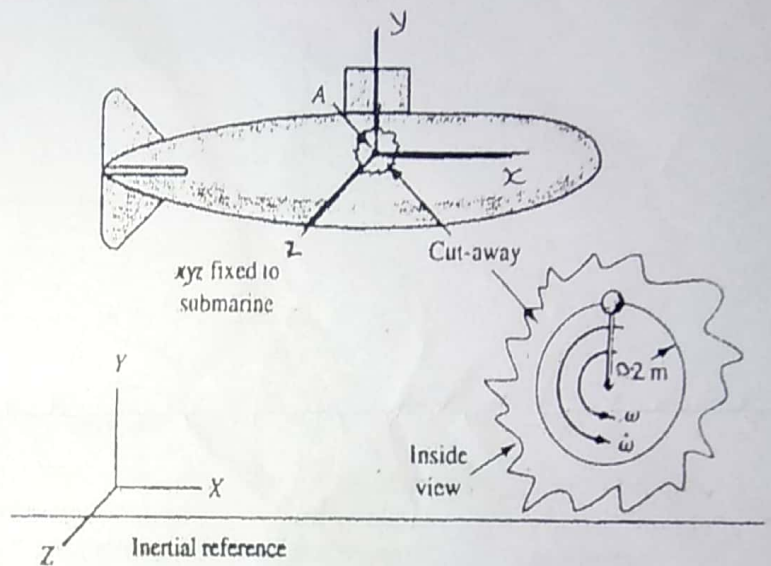


Figure 2

3. The end B of rod AB travels up the right half of the parabola in Figure 3 at the constant speed of 0.3 m/s. Find:

- (a) angular velocity of the rod AB
 (b) the velocity of point A, which is at the origin at the given instant.
 (c) angular acceleration of the rod
 (d) the acceleration of its endpoint A.

[14]

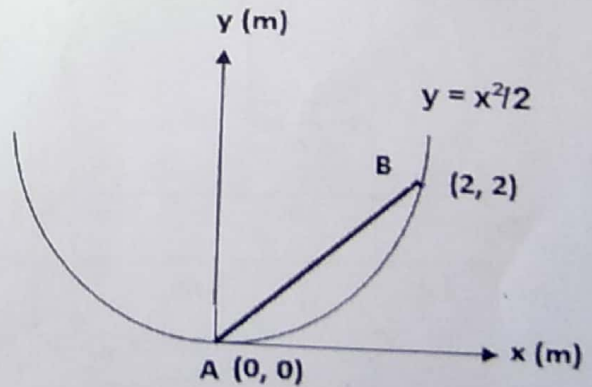


Figure 3

4. A bent rod is pin jointed to the disk at A (OA is along x-axis). The rod rotates at $\omega_1 = 5 \text{ rad/s}$ as shown in Figure 4. The bottom of the disk at 'B' rolls without slip on ground. Point P slides in a circular groove of radius 1 m at a speed of 1 m/s which is increasing at a rate of 2 m/s^2 relative to the disk as shown.
- Find the angular velocity and the angular acceleration of the disk relative to the ground frame of reference.
 - Find the acceleration of A relative to the ground frame of reference.
 - Find the velocity and acceleration of P relative to the disk.
 - Find the acceleration of P relative to the ground frame of reference.

[20]

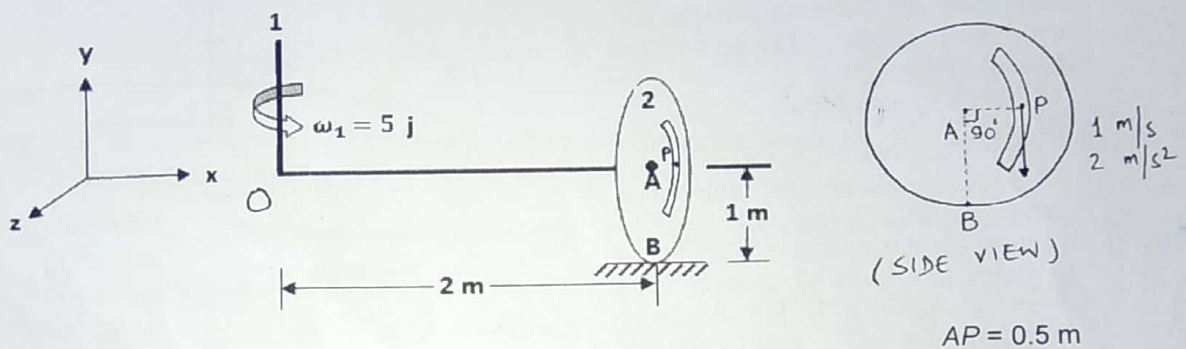


Figure 4

5. A beam OD has loads as shown in Figure 5. AEF is a bracket with a load of 100 N. (a) Determine the equivalent force couple system at A when load at F is transferred to A. (b) Determine the resultant force system at O. (c) Compute the simplest resultant for the loads shown and find its line of action.

[7]

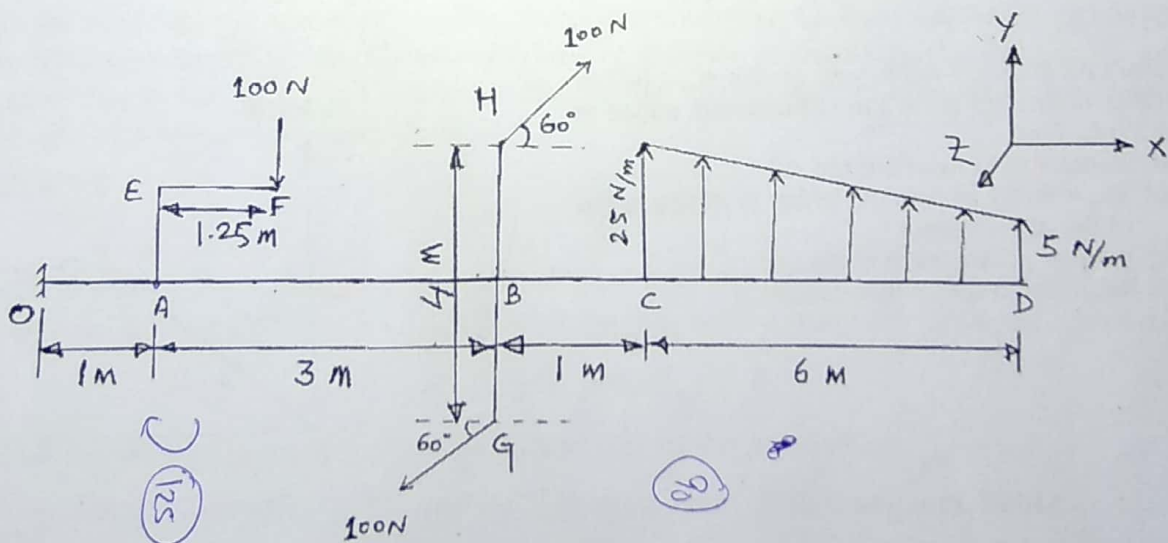


Figure 5