ME 1020: Engineering Mechanics

Quiz-1: Solution

Total Marks: 50

1. (a) The Free Body Diagrams for each cases are shown below Figures 1 to 4.

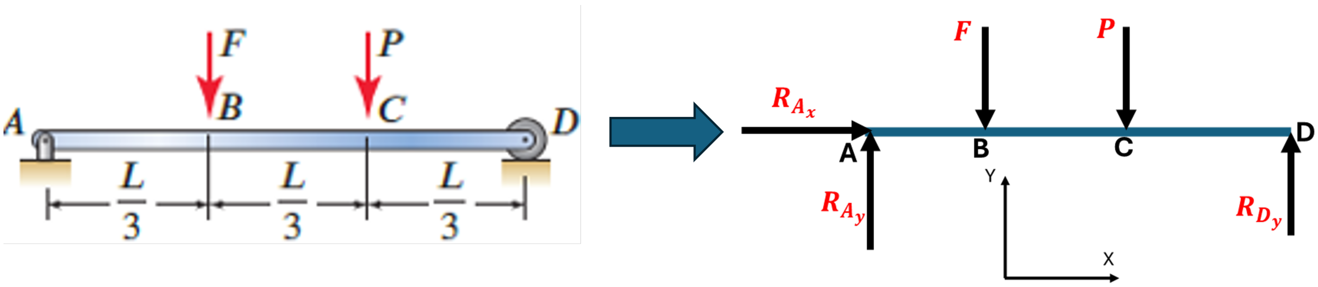

Figure 1

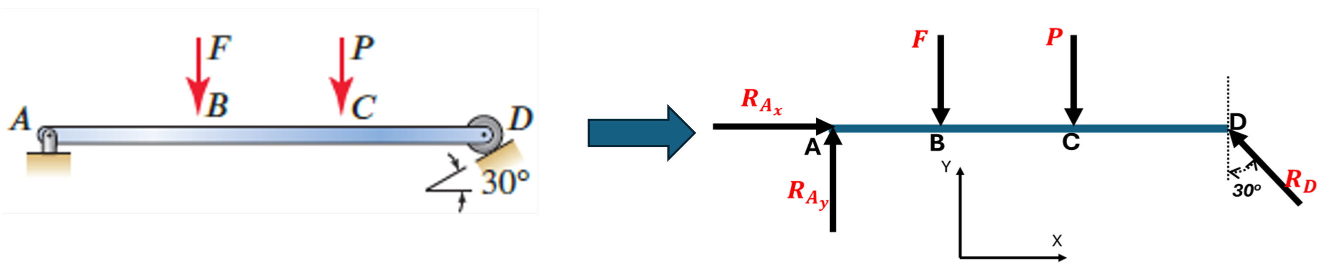

Figure 2

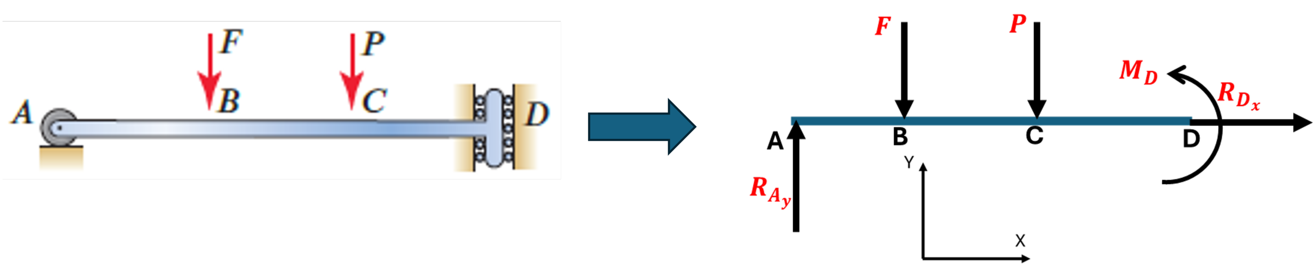

Figure 3

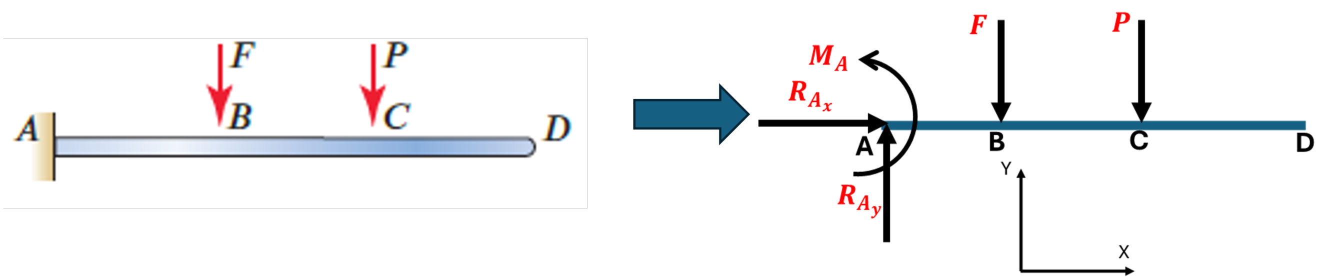

Figure 4

(b) i. From the FBD shown in Figure 1, takin a moment about point A and applying moment equilibrium,

$$\sum M_A = 0$$
$$\Rightarrow R_{D_y} \times L - P\frac{2L}{3} - F\frac{L}{3} = 0$$
$$\Rightarrow R_{D_y} = \frac{2P + F}{3}$$

Applying force equilibrium along y-axis,

$$\sum F_y = 0$$
$$\Rightarrow R_{A_y} + R_{D_y} - P - F = 0$$
$$\Rightarrow R_{A_y} = \frac{P + 2F}{3}$$

Applying force equilibrium along x-axis,

$$\sum F_x = 0$$
$$\Rightarrow R_{A_x} = 0$$

ii. From the FBD shown in Figure 2, takin a moment about point A and applying moment equilibrium,

$$\sum M_A = 0$$
$$\Rightarrow R_D \cos 30 \times L - P\frac{2L}{3} - F\frac{L}{3} = 0$$
$$\Rightarrow R_D = \frac{2}{3\sqrt{3}}(2P + F)$$

Applying force equilibrium along y-axis,

$$\sum F_y = 0$$
$$\Rightarrow R_{A_y} + R_D \cos 30 - P - F = 0$$
$$\Rightarrow R_{A_y} = \frac{P + 2F}{3}$$

Applying force equilibrium along x-axis,

$$\sum F_x = 0$$
$$\Rightarrow R_{A_x} - R_D \sin 30 = 0$$
$$\Rightarrow R_{A_x} = \frac{2P + F}{3\sqrt{3}}$$

iii. From the FBD shown in Figure 3, takin a moment about point A and applying moment equilibrium,

$$\sum M_A = 0$$
$$\Rightarrow M_D - P\frac{2L}{3} - F\frac{L}{3} = 0$$
$$\Rightarrow M_D = \frac{2P + F}{3}L$$

Applying force equilibrium along the y-axis,

$$\sum F_y = 0$$
$$\Rightarrow R_{A_y} - P - F = 0$$
$$\Rightarrow R_{A_y} = P + F$$

Applying force equilibrium along the x-axis,

$$\sum F_x = 0$$
$$\Rightarrow R_{D_x} = 0$$

iv. From the FBD shown in Figure 4, takin a moment about point A and applying moment equilibrium,

$$\sum M_A = 0$$
$$\Rightarrow M_A - P\frac{2L}{3} - F\frac{L}{3} = 0$$
$$\Rightarrow M_A = \frac{2P + F}{3}L$$

Applying force equilibrium along y-axis,

$$\sum F_y = 0$$
$$\Rightarrow R_{A_y} - P - F = 0$$
$$\Rightarrow R_{A_y} = P + F$$

Applying force equilibrium along x-axis,

$$\sum F_x = 0$$
$$\Rightarrow R_{D_x} = 0$$

2. (a) The Free Body Diagram of the link ABC and the bar CD is shown below.

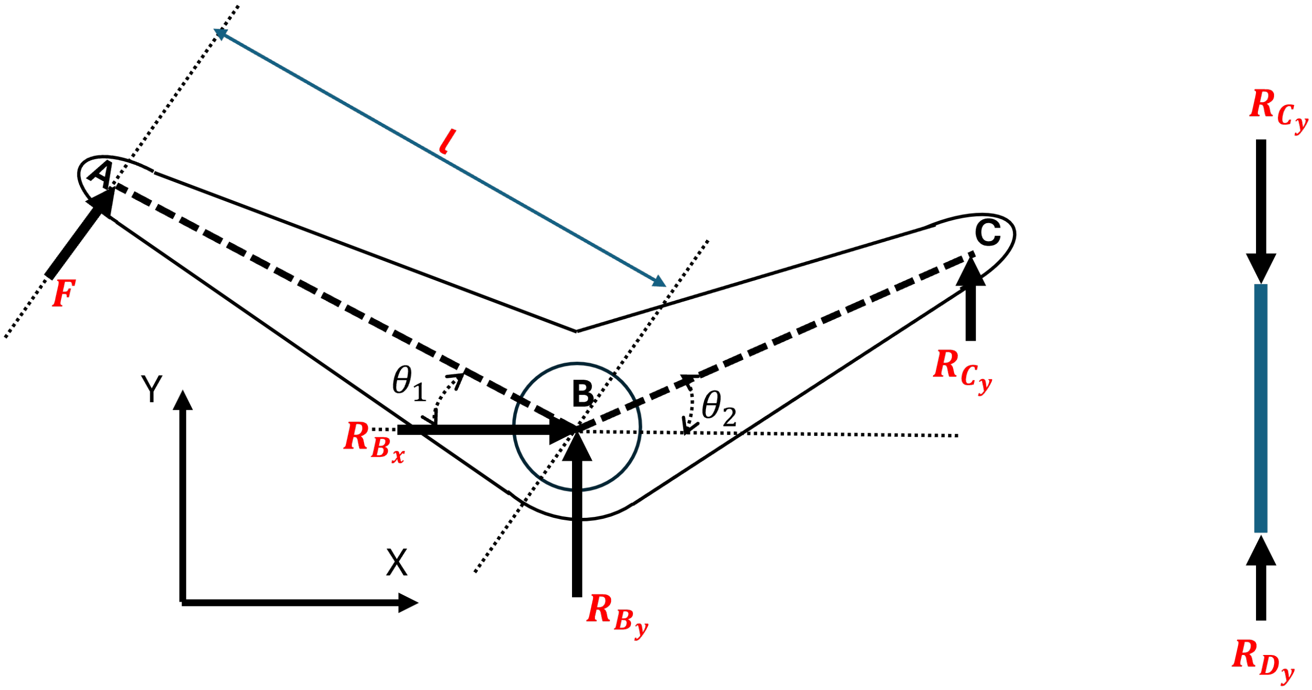

Figure 5

(b) From the FBD of the bar CD shown in Figure 5, applying force equilibrium along y-axis,

$$\sum F_y = 0$$
$$\Rightarrow R_{D_y} - R_{C_y} = 0$$
$$\Rightarrow R_{D_y} = R_{C_y}$$

Since the maximum magnitude of the force in the bar CD can be $P_{max} = 10kN$, the maximum reaction force at C will be $R_{C_y} = 10kN$.
From the FBD of the link ABC shown in Figure 5, takin a moment about point B gives,

$$\sum M_A = 0$$
$$\Rightarrow F \times l - R_{C_y} \times l \cos\theta_2 = 0$$
$$\Rightarrow F = R_{C_y} \cos\theta_2$$

The maximum force that can be applied at A will then be $F = 10\cos\theta_2 kN$.