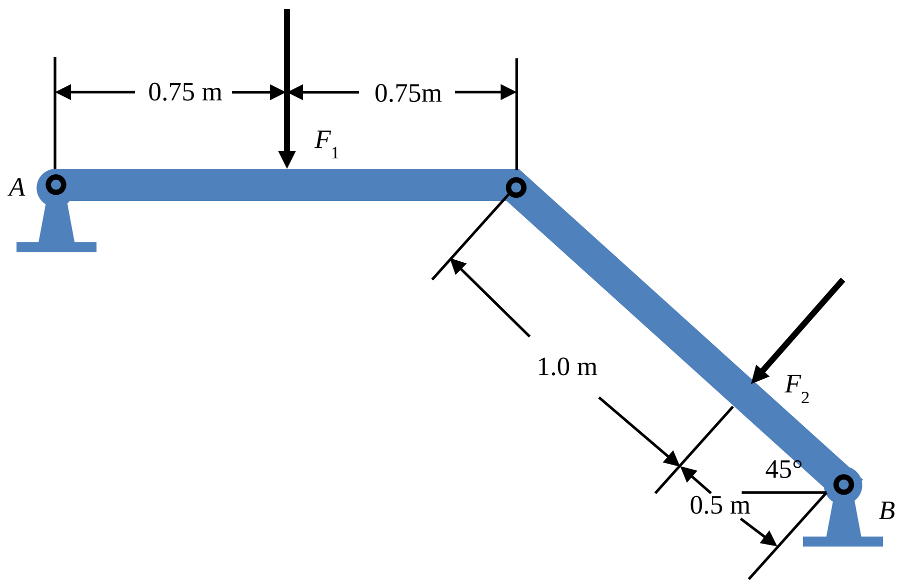
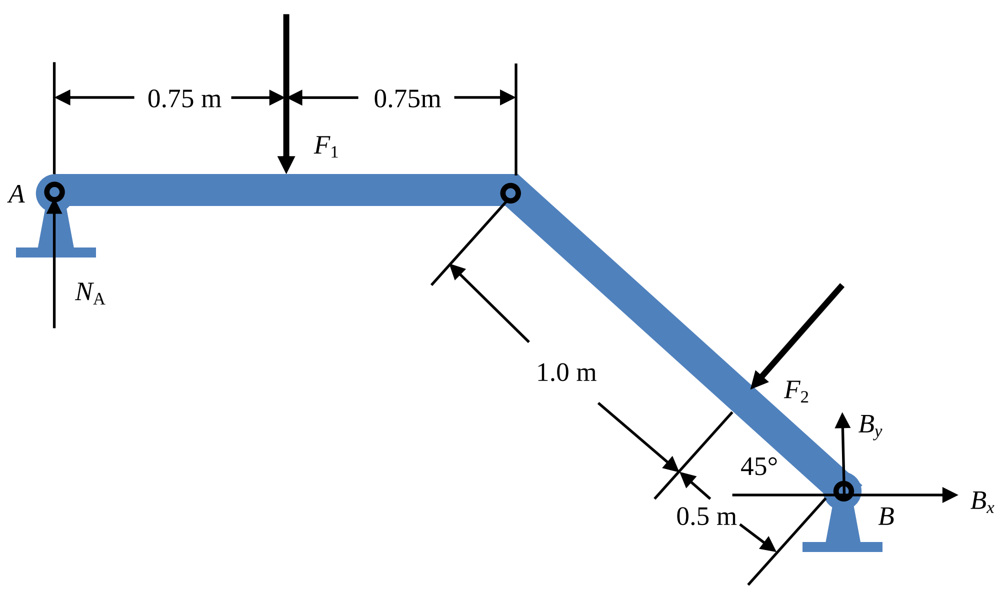
12. Two random forces $F_1 \sim N(12, 0.5^2)$ kN and $F_2 \sim N(8, 0.2^2)$ kN act on the structural system. F_1 and F_2 are independent. Determine the normal reaction distribution at the roller A and distributions of horizontal and vertical components at pin B for equilibrium of the member.



Solution



$$\sum M_B = 0; \quad F_1(0.75 + 1.5\cos 45^\circ) + F_2(0.5) - N_A(1.5 + 1.5\cos 45^\circ) = 0,$$
$$\sum F_x = 0; \quad B_x - F_2 \cos 45^\circ = 0,$$
$$\sum F_y = 0; \quad B_y + N_A - F_2 \sin 45^\circ - F_1 = 0.$$

Since, F_1 and F_2 follow the normal distributions which are independent with each other, we have

$$\mu_{N_A} = \frac{0.75 + 1.5\cos 45^\circ}{1.5 + 1.5\cos 45^\circ}\mu_{F_1} + \frac{0.5}{1.5 + 1.5\cos 45^\circ}\mu_{F_2} = 10.05 \text{ kN},$$
$$\sigma_{N_A} = \sqrt{(\frac{0.75 + 1.5\cos 45^\circ}{1.5 + 1.5\cos 45^\circ}\sigma_{F_1})^2 + (\frac{0.5}{1.5 + 1.5\cos 45^\circ}\sigma_{F_2})^2} = 0.36,$$
$$\mu_{B_x} = \cos 45^\circ \mu_{F_2} = 5.66 \text{ kN},$$
$$\sigma_{B_x} = \cos 45^\circ \sigma_{F_2} = 0.14,$$
$$\mu_{B_y} = \mu_{F_1} + \sin 45^\circ \mu_{F_2} - \mu_{N_A} = 7.61 \text{ kN},$$
$$\sigma_{B_y} = \sqrt{(\sigma_{F_1})^2 + (\sin 45^\circ \sigma_{F_2})^2 + \mu^2{}_{N_A}} = 0.63.$$

Therefore, we have $N_A \sim N(10.05, 0.36^2)$ kN, $B_x \sim N(5.66, 0.14^2)$ kN and $B_y \sim N(7.61, 0.63^2)$ kN. **Ans.**