Solutions to Static Equilibrium and Force Systems Problems

Civil Engineering Licensure Exam – Mock Exam

February 24, 2025

Problem 1: Force Components

A force of 500 N is applied at a 30° angle to the horizontal. Determine its horizontal and vertical components.

Solution:

$$F_x = F \cdot \cos(\theta) = 500 \times \cos(30^\circ) = 500 \times \frac{\sqrt{3}}{2} = 433 \text{ N}$$

$$F_y = F \cdot \sin(\theta) = 500 \times \sin(30^\circ) = 500 \times \frac{1}{2} = 250 \text{ N}$$

Reference: How to solve Static Equilibrium Problems — Forces

Problem 2: Beam Reaction Forces

A beam 6 m long is simply supported at both ends. A point load of 300 N is applied at 2 m from the left support. Determine the reaction forces at both supports.

Solution:

Taking moments about point A:

$$\sum M_A = 0 \Rightarrow R_B \times 6 - 300 \times 2 = 0$$

$$R_B = \frac{300 \times 2}{6} = 100 \text{ N}$$

Summing vertical forces:

$$\sum F_y = 0 \Rightarrow R_A + R_B - 300 = 0$$

$$R_A = 300 - 100 = 200 \text{ N}$$

Reference: Statics: System Equilibrium, 2D Reactions at the Supports

Problem 3: Moment Calculation

A force of 200 N is applied perpendicular to a lever arm at a distance of 0.8 m from the pivot. Determine the moment generated by the force.

Solution:

$$M = F \cdot d = 200 \times 0.8 = 160 \text{ N} \cdot \text{m}$$

Reference: Static Equilibrium - Tension, Torque, Lever, Beam, & Ladder Problem

Problem 4: Beam with Uniform Load

A uniform beam weighing 600 N is supported at its ends and carries a 400 N load at its midpoint. Determine the reactions at the supports.

Solution:

For a symmetric beam with a central load:

$$R_A = R_B = \frac{600 + 400}{2} = 500 \text{ N}$$

Reference: Statics: System Equilibrium, 2D Reactions at the Supports

Problem 5: Equilibrium of Three Forces

A structure is in static equilibrium under the action of three forces. The first force is 500 N at 0° (horizontal), and the second force is 300 N at 90° (vertical). Determine the magnitude and direction of the third force required to maintain equilibrium.

Solution:

$$F_3 = -(F_1 + F_2) = -(500\hat{i} + 300\hat{j})$$

$$|F_3| = \sqrt{500^2 + 300^2} = \sqrt{250000 + 90000} = \sqrt{340000} \approx 583 \text{ N}$$

The direction θ:

$$\theta = \tan^{-1}\left(\frac{300}{500}\right) = \tan^{-1}(0.6) \approx 31^\circ$$

Reference: How to Find the Unknown Forces – Static Equilibrium