*Name* _____

ID no. _____

Section _____

General instructions. Fill in the information asked above. Write legibly your solutions and answers in the answer sheets provided. Submit this questionnaire along with the answer sheet.

Part I. For fill-in-the-blank questions, each blank is worth a point. For true-or-false questions, write only *T* or *F*. For identification questions, each desired item is worth a point.

1. A _____ vector is one that may be freely moved in space.
2. The _____ of a force refers to its tendency to cause rotation about a point or an axis.
3. *True or False.* A couple is a pair of forces having equal magnitudes but opposing directions.
4. A _____ is an idealization of an object whose dimensions are deemed negligible.
5. *True or False.* The moment of a force K about a point A is perpendicular to both K and the position vector from the A to any point in the line of action of K.
6. A _____ force system is one in which the lines of actions of all the forces lie in the same plane.
7. The coordinate direction angles of the path from (0, 4, 20) in to (17, 3, 13) cm measure $\alpha =$ __, $\beta =$ __, and $\gamma =$ __ degrees.
8. The principle of moments is also known as _____ theorem.
9. A _____ vector is one that can be moved along their lines of action.
10. The principle of _____ states that the equilibrium conditions for a rigid body will remain unchanged if a force F acting at a given point of the rigid body is replaced by a force G of the same magnitude and same direction, but acting at a different point, as long as F and G have the same line of action.
11. A force vector is characterized by its _____, _____, and _____.
12. An 8-m long boom has one of its ends connected to a taut cable capable of bearing 20 kN. The maximum moment about the other end is attained when the smaller angle between the cable and the boom is _____ degrees.
13. *True or False.* Two couples having the same moment are equivalent.
14. A _____ force system is one in which the lines of actions of all the forces intersect at a common point.
15. Name three scenarios for which a force vector induces a zero moment about an axis.

Part II. Where applicable, provide force diagrams. Enclose final answers in boxes, with non-integer values rounded to three (3) decimal places. Each problem is worth a maximum of twenty (20) points.
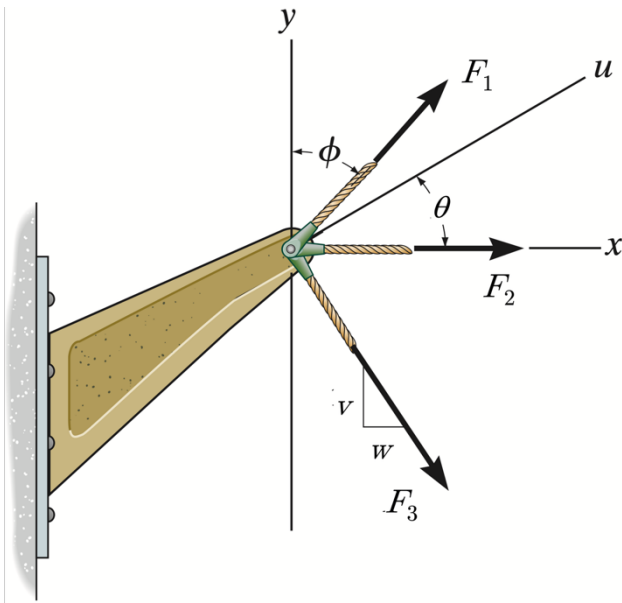
Problem 1. The bracket must be subject to a net force acting along the u-axis when $\theta = 40°$, $F_2 = 500$ lb, $F_3 = 5$ kip, $v = 5$, and $w = 3$.

a. (10 points) Determine F_1 (in kips) and ϕ (in degrees) for which the net force is a minimum. Use the triangle rule of vector addition.

b. (10 points) If the net force must be no more than 10 kips, what are the limiting values of F_1 (in kips) and ϕ (in degrees)? Use resolution of forces into x- and y-components.

Problem 2. A pot hangs through cords AB, AC, and AD, which can sustain tensions of up to 60, 50, and 35 N, respectively. How many kilograms must the pot weigh if $\theta_1 = 40°$, $\theta_2 = 20°$, $\theta_3 = 30°$, and $\theta_4 = 50°$? Take AB to lie in the yz-plane. Be sure to include equilibrium equations.
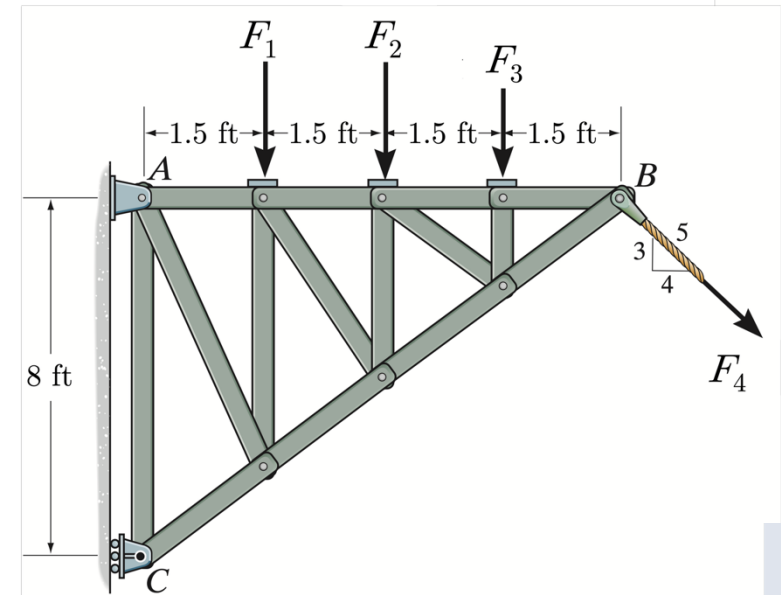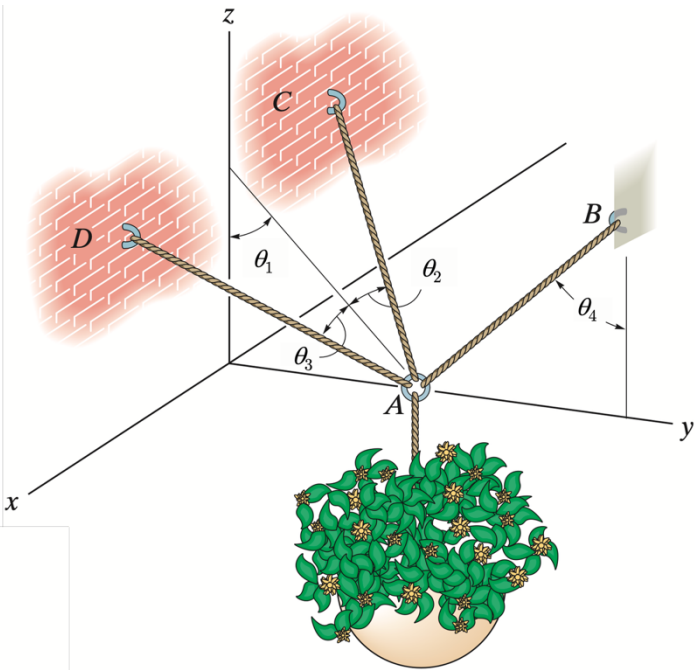
Problem 3. The truss is expected to be loaded with four concentrated forces: $F_1 = 0.15$ kip, $F_2 = 2$ kip, $F_3 = 0.5$ kip, and $F_4 = 0.1$ kip.

a. (15 points) Determine the force-couple equivalent (in kips and kip-ft) of the loads at C.

b. (5 points) How far (in ft) from C does a single-force equivalent of the loads intersect segment BC?

Problem 4. An initial design for a concrete foundation features a circular mat supporting four square columns, equally spaced around the center of the mat. Each column has a cross-sectional area of 90000 mm^2 and is so positioned such that its innermost face is 3.7 m from the center of the mat. The design also assumes that the loads transmitted by the columns pass through the centers of their cross sections, and that the mat thickness is negligible.

a. (15 points) Determine the equivalent force-couple (in kN and kN-m) of the column loads at O.

b. (5 points) Determine the coordinates (in m) of where the single-force equivalent of the column loads intersects the mat.