

*Solutions Manual for Engineering
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Answers to Selected Problems

Chapter 1

- 1-1** a) 3.46 m, b) 45.6 s, c) 5.56 kN, d) 4.52 Mg
1-2 a) GN/s, b) Gg/N, c) GN/(kg · s)
1-3 a) Gg/m, b) kN/s, c) mm · kg
1-5 a) 45.3 MN, b) 56.8 km, c) 5.63 μ g
1-6 $\rho_w = 2.42 \text{ Mg/m}^3$
1-7 a) 0.431 g, b) 35.3 kN, c) 5.32 m
1-9 a) km/s, b) mm, c) Gs/kg, d) mm · N
1-10 a) $m = 2.04 \text{ g}$, b) $m = 15.3 \text{ Mg}$, c) $m = 6.12 \text{ Gg}$
1-11 a) 27.5 kN/m³, b) 0.508 mm/s, c) 1.13 kN · m
1-13 $\rho_{al} = 2.71 \text{ Mg/m}^3$
1-14 a) $44.9(10^{-3}) \text{ N}^2$, b) $2.79(10^3) \text{ s}^2$, c) 23.4 s
1-15 a) $m_e = 3.65 \text{ Gg}$, b) $W_e = 35.8 \text{ MN}$,
c) $W_m = 5.89 \text{ MN}$, d) $m_m = 3.65 \text{ Gg}$
1-17 $v = 88.5 \text{ km/h}$, $v = 24.6 \text{ m/s}$
1-18 a) 8.53 km/kg², b) 135 m² · kg³
1-19 a) 4.66 m, b) 55.6 s, c) 4.56 kN, d) 2.77 Mg
1-21 $F = 10.0 \text{ nN}$, $W_1 = 78.5 \text{ N}$, $W_2 = 118 \text{ N}$

Chapter 2

- 2-1** $F_R = 320 \text{ lb}$, $\theta = 176^\circ$
2-2 $F_R = 474 \text{ lb}$, $\theta = 75.4^\circ$
2-3 $\theta = 10.9^\circ$, $F_{\min} = 235 \text{ lb}$
2-5 $\theta = 18.6^\circ$, $F = 319 \text{ N}$
2-6 $F_R = 8.03 \text{ kN}$, $\phi = 1.22^\circ$
2-7 $(F_1)_v = 2.93 \text{ kN}$, $(F_1)_u = 2.07 \text{ kN}$
2-9 $F_R = 464 \text{ N}$, $\theta = 78.6^\circ$
2-10 $F_R = 222 \text{ N}$, $\theta = 4.26^\circ$
2-11 $F_a = 30.6 \text{ lb}$, $F_b = 26.9 \text{ lb}$
2-13 $F_{AB} = 186 \text{ lb}$, $F_{AC} = 239 \text{ lb}$
2-14 $F = 616 \text{ lb}$, $\theta = 46.9^\circ$
2-15 $F_{lu} = 205 \text{ N}$, $F_{lv} = 160 \text{ N}$
2-17 $F_R = 19.2 \text{ N}$ ∇ 2.37°
2-18 $F_R = 19.2 \text{ N}$ ∇ 2.37°
2-19 $F_A = 439 \text{ N}$, $F_B = 311 \text{ N}$
2-21 $\theta = 53.5^\circ$, $F_{AB} = 621 \text{ lb}$
2-22 $F_{AC} = 323 \text{ lb}$, $\phi = 38.3^\circ$
2-23 $F_C = 4.51 \text{ kN}$, $F_B = 5.96 \text{ kN}$
2-25 $F_{AB} = 485 \text{ lb}$
2-26 $\theta = 54.3^\circ$, $F_A = 686 \text{ N}$
2-27 $F_R = 1.23 \text{ kN}$, $\theta = 6.08^\circ$
2-29 $T = 744 \text{ lb}$, $\theta = 23.8^\circ$
2-30 $T = 54.7 \text{ lb}$, $P = 42.6 \text{ lb}$
2-31 $\theta = 60^\circ$, $P = 40 \text{ lb}$, $T = 69.3 \text{ lb}$
2-33 $F_R = 747 \text{ N}$ ∇ 85.5°
2-34 $\mathbf{F}_1 = \{20\mathbf{i} + 34.6\mathbf{j}\} \text{ lb}$, $\mathbf{F}_2 = \{47.0\mathbf{i} - 17.1\mathbf{j}\} \text{ lb}$
2-35 $F_R = 69.2 \text{ lb}$ ∇ 14.7°

- 2-37** $F_R = 391 \text{ lb}$ ∇ 4.12°
2-38 $1.22 \text{ kN} \leq P \leq 3.17 \text{ kN}$
2-39 $F_{1x} = 141 \text{ N}$, $F_{1y} = 141 \text{ N}$, $F_{2x} = -130 \text{ N}$,
 $F_{2y} = 75 \text{ N}$
2-41 $F_R = 25.1 \text{ kN}$, $\theta = 185^\circ$
2-42 $\mathbf{F}_1 = \{680\mathbf{i} - 510\mathbf{j}\} \text{ N}$, $\mathbf{F}_2 = \{-312\mathbf{i} - 541\mathbf{j}\} \text{ N}$,
 $\mathbf{F}_3 = \{-530\mathbf{i} + 530\mathbf{j}\} \text{ N}$
2-43 $F_R = 546 \text{ N}$, $\theta = 253^\circ$
2-45 $\mathbf{F}_1 = \{F_1 \cos \theta \mathbf{i} + F_1 \sin \theta \mathbf{j}\} \text{ N}$, $\mathbf{F}_2 = \{350\mathbf{i}\} \text{ N}$,
 $\mathbf{F}_3 = \{-100\mathbf{j}\} \text{ N}$, $\theta = 67.0^\circ$ ∇ , $F_1 = 434 \text{ N}$
2-46 $\theta = 68.6^\circ$, $F_B = 480 \text{ lb}$
2-47 $F_R = 420 \text{ lb}$ ∇ 14.8°
2-49 $F_R = 389 \text{ N}$, $\psi = 42.7^\circ$
2-50 $\mathbf{F}_1 = \{-52.0\mathbf{i} + 30\mathbf{j}\} \text{ lb}$, $\mathbf{F}_2 = \{-47.0\mathbf{i} - 17.1\mathbf{j}\} \text{ lb}$
2-51 $F_R = 99.8 \text{ lb}$, $\theta = 173^\circ$
2-53 $\theta = 103^\circ$, $F_2 = 88.1 \text{ lb}$
2-54 $F_R = 161 \text{ lb}$ ∇ 38.3°
2-55 $F_R = 29.3 \text{ lb}$, $\theta = 347^\circ$
2-57 $F_R = 380 \text{ N}$, $F_1 = 57.8 \text{ N}$
2-58 $\theta = 86.0^\circ$, $F = 1.97 \text{ kN}$
2-59 $F_R = 11.1 \text{ kN}$ ∇ 47.7°
2-61 $\beta = 120^\circ$, $\mathbf{F} = \{30\mathbf{i} - 30\mathbf{j} + 42.4\mathbf{k}\} \text{ N}$
2-62 $\mathbf{F} = \{289\mathbf{i} + 225\mathbf{j} - 261\mathbf{k}\} \text{ lb}$
2-63 $F_R = 114 \text{ lb}$, $\alpha = 62.1^\circ$, $\beta = 113^\circ$, $\gamma = 142^\circ$
2-65 $\alpha = 46.1^\circ$, $\beta = 114^\circ$, $\gamma = 53.1^\circ$
2-66 $F_R = 799 \text{ N}$, $\alpha = 58.7^\circ$, $\beta = 84.4^\circ$, $\gamma = 32.0^\circ$
2-67 $F_3 = 166 \text{ N}$, $\alpha = 97.5^\circ$, $\beta = 63.7^\circ$, $\gamma = 27.5^\circ$
2-69 $F = 50 \text{ N}$, $\alpha = 74.1^\circ$, $\beta = 41.3^\circ$, $\gamma = 53.1^\circ$
2-70 $F_R = 384 \text{ N}$, $\alpha = 14.8^\circ$, $\beta = 88.9^\circ$, $\gamma = 105^\circ$
2-71 $F_1 = 429 \text{ lb}$, $\alpha_1 = 62.2^\circ$, $\beta_1 = 110^\circ$, $\gamma_1 = 145^\circ$
2-73 $\alpha_1 = 45.6^\circ$, $\beta_1 = 53.1^\circ$, $\gamma_1 = 66.4^\circ$
2-74 $\alpha_1 = 90^\circ$, $\beta_1 = 53.1^\circ$, $\gamma_1 = 66.4^\circ$
2-75 $\mathbf{F}_1 = \{14\mathbf{j} - 48\mathbf{k}\} \text{ lb}$, $\mathbf{F}_2 = \{90\mathbf{i} - 127\mathbf{j} + 90\mathbf{k}\} \text{ lb}$
2-77 $F = 113 \text{ lb}$, $\alpha = 45^\circ$, $\beta = 69.3^\circ$, $\gamma = 128^\circ$
2-78 $\mathbf{F}_1 = \{-159\mathbf{i} + 276\mathbf{j} + 318\mathbf{k}\} \text{ N}$,
 $\mathbf{F}_2 = \{424\mathbf{i} + 300\mathbf{j} - 300\mathbf{k}\} \text{ N}$, $\gamma_2 = 120^\circ$
2-79 $F_R = 634 \text{ N}$, $\alpha = 65.3^\circ$, $\beta = 24.8^\circ$, $\gamma = 88.4^\circ$
2-81 $F_R = 1.55 \text{ kip}$, $\alpha = 82.4^\circ$, $\beta = 37.6^\circ$, $\gamma = 53.4^\circ$
2-82 $F_R = 1.60 \text{ kip}$, $\alpha = 82.6^\circ$, $\beta = 29.4^\circ$, $\gamma = 61.7^\circ$
2-83 $\alpha_3 = 139^\circ$, $\beta_3 = 128^\circ$, $\gamma_3 = 102^\circ$, if $F_R = 387 \text{ lb}$,
 $\beta_3 = 60.7^\circ$, $\gamma_3 = 64.4^\circ$, if $F_R = 1.41 \text{ kip}$
2-85 $F = 2.02 \text{ kN}$, $F_y = 0.523 \text{ kN}$
2-86 $r_{AB} = 2.11 \text{ m}$
2-87 $r_{AB} = 9.06 \text{ in.}$
2-89 $x = 5.06 \text{ m}$, $y = 3.61 \text{ m}$, $z = 6.51 \text{ m}$
2-90 $z = 6.63 \text{ ft}$
2-91 $x = y = 4.42 \text{ ft}$
2-93 $\mathbf{F}_B = \{-400\mathbf{i} - 200\mathbf{j} + 400\mathbf{k}\} \text{ N}$,
 $\mathbf{F}_C = \{-200\mathbf{i} + 200\mathbf{j} + 350\mathbf{k}\} \text{ N}$

- 2-94** $F_R = 960 \text{ N}$, $\alpha = 129^\circ$, $\beta = 90^\circ$, $\gamma = 38.7^\circ$
2-95 $\mathbf{F}_A = \{-1.46\mathbf{i} + 5.82\mathbf{k}\} \text{ kN}$,
 $\mathbf{F}_C = \{0.857\mathbf{i} + 0.857\mathbf{j} + 4.85\mathbf{k}\} \text{ kN}$,
 $\mathbf{F}_B = \{0.970\mathbf{i} - 1.68\mathbf{j} + 7.76\mathbf{k}\} \text{ kN}$, $F_R = 18.5 \text{ kN}$,
 $\alpha = 88.8^\circ$, $\beta = 92.6^\circ$, $\gamma = 2.81^\circ$
2-97 $F_R = 378 \text{ lb}$, $\alpha = 149^\circ$, $\beta = 90^\circ$, $\gamma = 59.0^\circ$
2-98 $F_R = 1.48 \text{ kN}$, $\alpha = 86.9^\circ$, $\beta = 77.5^\circ$, $\gamma = 167^\circ$
2-99 $r_{OA} = 7.32 \text{ ft}$
2-101 $F_R = 1.54 \text{ kN}$, $\alpha = 84.8^\circ$, $\beta = 171^\circ$, $\gamma = 97.5^\circ$
2-102 $F_C = 442 \text{ N}$, $F_B = 318 \text{ N}$, $F_D = 866 \text{ N}$
2-103 N/A
2-105 $F_{OA} = 31.4 \text{ lb}$
2-106 $(F_{AB})_z = 600 \text{ lb}$
2-107 $(F_{AC})_z = 569 \text{ lb}$
2-109 $F_1 = 333 \text{ N}$, $F_2 = 373 \text{ N}$
2-110 $\theta = 74.4^\circ$, $\phi = 55.4^\circ$
2-111 $\theta = 34.2^\circ$
2-113 $F_{||} = 4.07 \text{ N}$, $F_{\perp} = 23.1 \text{ N}$
2-114 $\theta = 70.5^\circ$
2-115 $\phi = 65.8^\circ$
2-117 $\theta = 74.2^\circ$
2-118 $r_{BC} = 5.39 \text{ m}$
2-119 $\theta = 19.2^\circ$
2-121 $F_{CA} = 16.2 \text{ lb}$
2-122 $\theta = 115^\circ$, $F_{1y} = 300 \text{ N}$, $F_{2y} = 90 \text{ N}$
2-123 $(F_2)_{F1} = 71.6 \text{ N}$
2-125 $F_{AC} = 26.5 \text{ lb}$, $F_{BA} = 66.4 \text{ lb}$
2-126 $F_u = 246 \text{ N}$
2-127 $F_{AC} = 366 \text{ N}$, $\mathbf{F}_{AC} = \{293\mathbf{j} + 219\mathbf{k}\} \text{ N}$
2-129 $F_{AB} = 31.1 \text{ N}$
2-130 $(\mathbf{F}_{AB})_{AC} = \{116\mathbf{i} - 231\mathbf{j} + 231\mathbf{k}\} \text{ N}$

Chapter 3

- 3-1** $F_{BA} = 3.92 \text{ kN}$, $F_{BC} = 3.40 \text{ kN}$
3-2 $F_{BC} = 2.90 \text{ kN}$, $y = 841 \text{ mm}$
3-3 $\theta_{\min} = 34.3^\circ$
3-5 $T = 720 \text{ lb}$, $F = 540 \text{ lb}$
3-6 $T = 766 \text{ lb}$, $\theta = 70.1^\circ$
3-7 $T_{BC} = 22.3 \text{ kN}$, $T_{BD} = 32.6 \text{ kN}$
3-9 $l'_{AB} = 0.448 \text{ ft}$, $l'_{AC} = 0.656 \text{ ft}$
3-10 $F_{CA} = 80.0 \text{ N}$, $F_{CB} = 90.4 \text{ N}$
3-11 $\theta = 64.3^\circ$, $F_{CB} = 85.2 \text{ N}$, $F_{CA} = 42.6 \text{ N}$
3-13 $F_{AC} = F_{AB} = \{2.45 \csc \theta\} \text{ kN}$,
 $(l_{AC})_{\min} = (l_{AB})_{\min} = 1.73 \text{ m}$
3-14 $s_{AD} = 0.5 \text{ ft}$, $s_{AC} = 0.808 \text{ ft}$, $s_{AB} = 0.476 \text{ ft}$
3-15 $W = 840 \text{ lb}$
3-17 $y = 6.59 \text{ m}$
3-18 $\theta = 35.0^\circ$
3-19 $l' = 2.66 \text{ ft}$

- 3-21** $m_{\max} = 2.78 \text{ Mg}$
3-22 $F = 15.8 \text{ lb}$
3-23 $d = 1.56 \text{ ft}$
3-25 $F = 39.3 \text{ lb}$
3-26 $T_{HA} = 294 \text{ N}$, $T_{AB} = 340 \text{ N}$, $T_{AE} = 170 \text{ N}$,
 $T_{BD} = 490 \text{ N}$, $T_{BC} = 562 \text{ N}$
3-27 $m_{\max} = 26.6 \text{ kg}$
3-29 $F_{ED} = 30.2 \text{ lb}$, $F_{EB} = 43.6 \text{ lb}$, $F_{BC} = 69.8 \text{ lb}$,
 $F_{BA} = 86.6 \text{ lb}$
3-30 $W_{\max} = 57.7 \text{ lb}$
3-31 $s = 5.33 \text{ ft}$
3-33 $d = 7.13 \text{ in.}$
3-34 $k = 6.80 \text{ lb/in.}$
3-35 $F_{BD} = 171 \text{ N}$, $F_{BC} = 145 \text{ N}$
3-37 $\theta_{\min} = 11.6^\circ$
3-38 $\theta = 60^\circ$, $T_{AB} = 34.6 \text{ lb}$
3-39 $\theta = 60^\circ$, $W_{\max} = 46.1 \text{ lb}$
3-41 $T_B = 34.6 \text{ mN}$, $T_A = 52.9 \text{ mN}$, $\theta = 19.1^\circ$,
 $m = 4.08 \text{ g}$
3-42 $\theta = 78.7^\circ$, $F_{CD} = 127 \text{ lb}$
3-43 $\alpha_3 = 77.2^\circ$, $\beta_3 = 148^\circ$, $\gamma_3 = 119^\circ$, $P = 639 \text{ lb}$
3-45 $T_B = 109 \text{ lb}$, $T_C = 47.4 \text{ lb}$, $T_D = 87.9 \text{ lb}$
3-46 $s_{OB} = 327 \text{ mm}$, $s_{OA} = 218 \text{ mm}$
3-47 $F_{AB} = 2.52 \text{ kN}$, $F_{CB} = 2.52 \text{ kN}$, $F_{BD} = 3.64 \text{ kN}$
3-49 $F_{AB} = 1.31 \text{ kN}$, $F_{AC} = 763 \text{ N}$, $F_{AD} = 708 \text{ N}$
3-50 $F_{AC} = F_{AD} = 312 \text{ N}$, $F_{AB} = 580 \text{ N}$
3-51 $F_{AB} = 520 \text{ N}$, $F_{AC} = F_{AD} = 260 \text{ N}$, $d = 3.61 \text{ m}$
3-53 $m_{\max} = 90.2 \text{ kg}$
3-54 $F_B = F_D = 858 \text{ N}$, $F_C = 0$
3-55 $m_{\max} = 2.62 \text{ Mg}$
3-57 $W_{\max} = 55.7 \text{ lb}$
3-58 $F_{AB} = 469 \text{ lb}$, $F_{AC} = F_{AD} = 331 \text{ lb}$
3-59 $F_{AC} = 574 \text{ lb}$, $F_{AB} = 500 \text{ lb}$, $F_{CD} = 1.22 \text{ kip}$,
 $F_{CE} = F_{CF} = 416 \text{ lb}$
3-61 $F_{AB} = F_{AC} = F_{AD} = 375 \text{ lb}$
3-62 $\theta = 0^\circ$, $F_{OA} = 149 \text{ lb (C)}$,
 $F_{OB} = F_{OC} = 74.5 \text{ lb (T)}$
3-63 $s = 333 \text{ mm}$
3-65 $F_{AE} = 2.91 \text{ kip (C)}$, $(T_{AD})_{\max} = 1.60 \text{ kip}$
3-66 $F_{AB} = F_{AC} = 16.6 \text{ kN}$, $F_{AD} = 55.2 \text{ kN}$
3-67 $h = 1.64 \text{ ft}$

Chapter 4

- 4-1** $(M_{F1})_A = 3 \text{ kip} \cdot \text{ft} \curvearrowright$, $(M_{F2})_A = 5.6 \text{ kip} \cdot \text{ft} \curvearrowright$,
 $(M_{F3})_A = 2.59 \text{ kip} \cdot \text{ft} \curvearrowright$
4-2 $(M_{F1})_B = 4.12 \text{ kip} \cdot \text{ft} \curvearrowright$, $(M_{F2})_B = 2 \text{ kip} \cdot \text{ft} \curvearrowright$,
 $(M_{F3})_B = 40 \text{ lb} \cdot \text{ft} \curvearrowright$
4-3 $(M_P)_A = 123 \text{ lb} \cdot \text{in.} \curvearrowright$, $F = 23.7 \text{ lb}$
4-5 $M_A = (1.2 \sin \theta + 0.8 \cos \theta) \text{ kN} \cdot \text{m}$

- 4-6 $(M_A)_{\min} = 0$ at $\theta = 146^\circ$
 4-7 $(M_O)_{\text{Case 1}} = 120 \text{ N} \cdot \text{m} \curvearrowright$,
 $(M_O)_{\text{Case 2}} = 520 \text{ N} \cdot \text{m} \curvearrowright$
 4-9 $(M_R)_B = 1.23 \text{ kN} \cdot \text{m} \curvearrowright$
 4-10 $M_O = 7.11 \text{ N} \cdot \text{m} \curvearrowright$
 4-11 $M_A = 7.71 \text{ N} \cdot \text{m} \curvearrowright$
 4-13 $(M_A)_{\max} = 79.8 \text{ N} \cdot \text{m} \curvearrowright$ at $\theta = 37.9^\circ$,
 $(M_A)_{\min} = 0$ at $\theta = 128^\circ$
 4-14 $\theta = 28.6^\circ$
 4-15 $(M_{FA})_C = 162 \text{ lb} \cdot \text{ft} \curvearrowright$, $(M_{FB})_C = 260 \text{ lb} \cdot \text{ft} \curvearrowright$,
Counterclockwise
 4-17 $(M_O)_{\max} = 80 \text{ kN} \cdot \text{m} \curvearrowright$, $x = 24.0 \text{ m}$
 4-18 $(M_O)_{\max} = 80 \text{ kN} \cdot \text{m} \curvearrowright$ at $\theta = 33.6^\circ$
 4-19 $M_C = 13.0 \text{ N} \cdot \text{m} \curvearrowright$, $F = 35.2 \text{ N}$
 4-21 $F_t = 618 \text{ N}$
 4-22 N/A
 4-23 N/A
 4-25 $\mathbf{M}_O = \{260\mathbf{i} + 180\mathbf{j} + 510\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-26 $\mathbf{M}_P = \{440\mathbf{i} + 220\mathbf{j} + 990\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-27 $(\mathbf{M}_{FB})_O = \{-1.8\mathbf{i}\} \text{ kN} \cdot \text{m}$
 4-29 $(\mathbf{M}_R)_O = \{-720\mathbf{i} + 720\mathbf{j}\} \text{ N} \cdot \text{m}$
 4-30 $\mathbf{M}_O = \{-84\mathbf{i} - 8\mathbf{j} - 39\mathbf{k}\} \text{ kN} \cdot \text{m}$
 4-31 $\mathbf{M}_P = \{-116\mathbf{i} + 16\mathbf{j} - 135\mathbf{k}\} \text{ kN} \cdot \text{m}$
 4-33 $\alpha = 77.8^\circ$, $\beta = 29.6^\circ$, $\gamma = 63.4^\circ$
 4-34 $\mathbf{M}_O = \{-128\mathbf{i} + 128\mathbf{j} - 257\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-35 $\mathbf{M}_B = \{-37.6\mathbf{i} + 90.7\mathbf{j} - 155\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-37 $\mathbf{M}_O = \{32.6\mathbf{i} - 69.3\mathbf{j} - 72\mathbf{k}\} \text{ lb} \cdot \text{ft}$
 4-38 $(\mathbf{M}_{F1})_O = \{110\mathbf{i} - 50\mathbf{j} + 90\mathbf{k}\} \text{ lb} \cdot \text{ft}$
 4-39 $(\mathbf{M}_{F2})_O = \{90\mathbf{i} - 130\mathbf{j} - 60\mathbf{k}\} \text{ lb} \cdot \text{ft}$
 4-41 $y = 2 \text{ m}$, $z = 1 \text{ m}$
 4-42 $y = 1 \text{ m}$, $z = 3 \text{ m}$, $d = 1.15 \text{ m}$
 4-43 $\mathbf{M}_A = \{-5.39\mathbf{i} + 13.1\mathbf{j} + 11.4\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-45 $\mathbf{M}_A = \{1.56\mathbf{i} - 0.750\mathbf{j} - 1.00\mathbf{k}\} \text{ kN} \cdot \text{m}$
 4-46 $\mathbf{M}_B = \{1.00\mathbf{i} + 0.750\mathbf{j} - 1.56\mathbf{k}\} \text{ kN} \cdot \text{m}$
 4-47 $(\mathbf{M}_{FA})_O = \{-18\mathbf{i} + 9\mathbf{j} - 3\mathbf{k}\} \text{ N} \cdot \text{m}$,
 $(\mathbf{M}_{FB})_O = \{18\mathbf{i} + 7.5\mathbf{j} + 30\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-49 $(\mathbf{M}_{F1})_A = \{-36\mathbf{i} - 36\mathbf{k}\} \text{ lb} \cdot \text{ft}$,
 $(\mathbf{M}_{F2})_A = \{-42\mathbf{i} - 14\mathbf{j} - 68\mathbf{k}\} \text{ lb} \cdot \text{ft}$,
 $(M_R)_A = 131 \text{ lb} \cdot \text{ft}$, $\alpha = 127^\circ$, $\beta = 96.1^\circ$,
 $\gamma = 143^\circ$
 4-50 $M = (10 \sqrt{127 \sin^2 \theta + 225}) \text{ N} \cdot \text{m}$,
 $M_{\max}$ at $\theta = 90^\circ$, $M_{\min}$ at $\theta = 0^\circ, 180^\circ$
 4-51 $\mathbf{M}_O = \{-1.77\mathbf{i} - 1.10\mathbf{j}\} \text{ kN} \cdot \text{m}$
 4-53 $F_{\max} = 770 \text{ N}$
 4-54 $\mathbf{M}_y = \{277\mathbf{j}\} \text{ N} \cdot \text{m}$
 4-55 $\mathbf{M}_x = \{77.1\mathbf{i}\} \text{ N} \cdot \text{m}$, $\mathbf{M}_z = \{-91.9\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-57 $P = 8.50 \text{ lb}$
 4-58 $M_x = 21.7 \text{ N} \cdot \text{m}$
 4-59 $F = 139 \text{ N}$
 4-61 $M_{AB} = 136 \text{ N} \cdot \text{m}$
 4-62 $M_{BC} = 165 \text{ N} \cdot \text{m}$
 4-63 $M_{CA} = 226 \text{ N} \cdot \text{m}$
 4-65 $(M_{F1})_z = 38.2 \text{ lb} \cdot \text{in.}$, $(M_{F2})_z = 14.1 \text{ lb} \cdot \text{in.}$
 4-66 $M_{AB} = 0$
 4-67 $(\mathbf{M}_R)_{Oa} = \{26.1\mathbf{i} - 15.1\mathbf{j}\} \text{ lb} \cdot \text{ft}$
 4-69 $F = 162 \text{ lb}$
 4-70 $M_y = 0.828 \text{ N} \cdot \text{m}$
 4-71 $M_{y'} = 464 \text{ lb} \cdot \text{ft}$
 4-73 $R = 28.9 \text{ N}$
 4-74 $F = 67.5 \text{ lb}$
 4-75 $F = 830 \text{ N}$
 4-77 $\theta = 56.1^\circ$
 4-78 $(M_C)_R = 9.69 \text{ kN} \cdot \text{m} \curvearrowright$
 4-79 $N = 26.0 \text{ N}$
 4-81 $\theta = 45^\circ$, $P = 49.5 \text{ N}$
 4-82 $M_c = 900 \text{ lb} \cdot \text{ft}$, $R_B = 500 \text{ lb}$
 4-83 $(M_C)_R = 5.20 \text{ kN} \cdot \text{m} \curvearrowright$
 4-85 $d = 5.54 \text{ ft}$
 4-86 $(M_C)_R = 53.4 \text{ lb} \cdot \text{ft} \curvearrowright$
 4-87 $(M_C)_R = 53.4 \text{ lb} \cdot \text{ft} \curvearrowright$
 4-89 $(M_C)_R = 96.0 \text{ lb} \cdot \text{ft}$, $\alpha = 47.4^\circ$, $\beta = 74.9^\circ$,
 $\gamma = 133^\circ$
 4-90 $M_3 = 318 \text{ lb} \cdot \text{ft}$, $M_1 = M_2 = 287 \text{ lb} \cdot \text{ft}$
 4-91 $(\mathbf{M}_C)_R = \{11.0\mathbf{i} - 49.0\mathbf{j} - 40\mathbf{k}\} \text{ lb} \cdot \text{ft}$,
 $(M_C)_R = 64.2 \text{ lb} \cdot \text{ft}$, $\alpha = 80.1^\circ$, $\beta = 140^\circ$,
 $\gamma = 129^\circ$
 4-93 $F = 992 \text{ N}$
 4-94 $\mathbf{M}_c = \{-65.0\mathbf{i} - 37.5\mathbf{k}\} \text{ N} \cdot \text{m}$, $M_c = 75 \text{ N} \cdot \text{m}$
 4-95 $F = 15.4 \text{ N}$
 4-97 $F = 832 \text{ N}$
 4-98 $(\mathbf{M}_C)_R = \{-12.1\mathbf{i} - 10\mathbf{j} - 17.3\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-99 $d = 342 \text{ mm}$
 4-101 $\mathbf{M}_c = \{7.01\mathbf{i} + 42.1\mathbf{j}\} \text{ N} \cdot \text{m}$
 4-102 $F = 35.1 \text{ N}$
 4-103 $F_R = 365 \text{ N} \nearrow 70.8^\circ$, $(M_R)_O = 2.36 \text{ kN} \cdot \text{m} \curvearrowright$
 4-105 $F_R = 464 \text{ lb} \searrow 45.1^\circ$, $(M_R)_B = 1.60 \text{ kip} \cdot \text{ft} \curvearrowright$
 4-106 $F_R = 464 \text{ lb} \searrow 45.1^\circ$, $(M_R)_A = 832 \text{ lb} \cdot \text{ft} \curvearrowright$
 4-107 $F_R = 461 \text{ N} \searrow 49.4^\circ$, $(M_R)_O = 438 \text{ N} \cdot \text{m} \curvearrowright$
 4-109 $F_R = 342 \text{ N} \nearrow 43.0^\circ$, $(M_R)_O = 99.5 \text{ N} \cdot \text{m} \curvearrowright$
 4-110 $F_R = 73.8 \text{ lb} \searrow 59.0^\circ$, $(M_R)_O = 359 \text{ lb} \cdot \text{ft} \curvearrowright$
 4-111 $\theta = 26.6^\circ$, $F = 8.94 \text{ kN}$, $d = 4.5 \text{ m}$
 4-113 $F_R = 29.9 \text{ lb} \nearrow 78.4^\circ$, $(M_R)_O = 214 \text{ lb} \cdot \text{in.} \curvearrowright$
 4-114 $F_R = 26.4 \text{ lb} \nearrow 85.7^\circ$, $(M_R)_O = 205 \text{ lb} \cdot \text{in.} \curvearrowright$
 4-115 $F_R = 219 \text{ lb} \nearrow 79.5^\circ$, $(M_R)_A = 1.19 \text{ kip} \cdot \text{ft} \curvearrowright$
 4-117 $F_R = 416 \text{ lb} \nearrow 35.2^\circ$, $(M_R)_O = 1.48 \text{ kip} \cdot \text{ft} \curvearrowright$
 4-118 $F_2 = 41.1 \text{ lb}$, $\theta = 44.9^\circ$, $F_1 = 36.8 \text{ lb}$
 4-119 $\mathbf{F}_R = \{-5\mathbf{i} - 35\mathbf{j} - 70\mathbf{k}\} \text{ N}$,
 $(\mathbf{M}_R)_O = \{-8.45\mathbf{i} + 4.9\mathbf{j} - 5.12\mathbf{k}\} \text{ N} \cdot \text{m}$
 4-121 $\mathbf{F}_R = \{-0.7\mathbf{j} - 2.2\mathbf{k}\} \text{ kip}$,
 $(\mathbf{M}_R)_A = \{19.6\mathbf{i} - 21.6\mathbf{j} + 8.4\mathbf{k}\} \text{ kip} \cdot \text{ft}$
 4-122 $\mathbf{F}_R = \{-30\mathbf{i} + 15\mathbf{j} + 45\mathbf{k}\} \text{ lb}$,
 $(\mathbf{M}_R)_O = \{80\mathbf{i} - 87.5\mathbf{j} + 102\mathbf{k}\} \text{ lb} \cdot \text{ft}$

- 4-123** $\mathbf{F}_R = \{506\mathbf{i} - 23.2\mathbf{j} + 1.24(10^3)\mathbf{k}\} \text{ N}$,
 $(\mathbf{M}_R)_O = \{-17.7\mathbf{i} - 600\mathbf{j} + 26.5\mathbf{k}\} \text{ N} \cdot \text{m}$
4-125 $\mathbf{F}_R = \{-70\mathbf{i} + 140\mathbf{j} - 408\mathbf{k}\} \text{ N}$,
 $(\mathbf{M}_R)_P = \{-26\mathbf{i} + 357\mathbf{j} + 127\mathbf{k}\} \text{ N} \cdot \text{m}$
4-126 $F_R = 10.8 \text{ kip} \downarrow$, $d = 13.7 \text{ ft} \rightarrow$
4-127 $F_R = 10.8 \text{ kip} \downarrow$, $d = 9.26 \text{ ft} \leftarrow$
4-129 $F_R = 58.3 \text{ lb} \nearrow 31.0^\circ$, $y = -3 \text{ ft}$
4-130 $F_R = 67.1 \text{ lb} \searrow 26.6^\circ$, $d = 8.25 \text{ in.} \uparrow$
4-131 $F_R = 1.30 \text{ kN} \searrow 84.5^\circ$, $x = 7.36 \text{ m} \rightarrow$
4-133 $F_R = 78.1 \text{ lb} \searrow 87.1^\circ$, $y = -25 \text{ ft}$
4-134 $F_R = 78.1 \text{ lb} \searrow 87.1^\circ$, $d = 31 \text{ ft}$
4-135 $F_R = 991 \text{ N} \searrow 63.0^\circ$, $y = 1.78 \text{ m} \uparrow$
4-137 $F_R = 65.9 \text{ lb} \searrow 49.8^\circ$, $d = 2.10 \text{ ft} \rightarrow$
4-138 $F_R = 65.9 \text{ lb} \searrow 49.8^\circ$, $d = 4.62 \text{ ft} \downarrow$
4-139 $F_R = 98.5 \text{ lb} \searrow 24.0^\circ$, $d = 4.33 \text{ ft} \uparrow$
4-141 $F_R = 197 \text{ lb} \searrow 42.6^\circ$, $d = 5.24 \text{ ft} \downarrow$
4-142 $F_R = 197 \text{ lb} \searrow 42.6^\circ$, $d = 0.824 \text{ ft} \leftarrow$
4-143 $F_R = 26 \text{ kN}$, $y = 82.7 \text{ mm}$, $x = 3.85 \text{ mm}$
4-145 $F_C = 600 \text{ N}$, $F_D = 500 \text{ N}$
4-146 $F_R = 700 \text{ lb}$, $z = 0.447 \text{ ft}$, $x = -0.117 \text{ ft}$
4-147 $F_B = 163 \text{ lb}$, $F_C = 223 \text{ lb}$
4-149 $z = 0.586 \text{ ft}$, $\mathbf{F}_R = \{-10\mathbf{j}\} \text{ lb}$, $\mathbf{M}_R = \{-14.1\mathbf{j}\} \text{ lb} \cdot \text{ft}$
4-150 $F_R = 108 \text{ lb}$, $M_R = -624 \text{ lb} \cdot \text{ft}$, $x = 8.69 \text{ ft}$,
 $y = 0.414 \text{ ft}$
4-151 $F_R = 495 \text{ N}$, $M_R = 1.54 \text{ kN} \cdot \text{m}$, $z = 1.16 \text{ m}$,
 $y = 2.06 \text{ m}$
4-153 $F_R = 30 \text{ kN} \downarrow$, $\bar{x} = 3.4 \text{ m} \rightarrow$
4-154 $F_R = 21 \text{ kN} \downarrow$, $d = 3.43 \text{ m} \rightarrow$
4-155 $a = 1.26 \text{ m}$, $b = 2.53 \text{ m}$
4-157 $F_R = 0.525 \text{ kN} \uparrow$, $d = 0.171 \text{ m} \rightarrow$
4-158 $F_R = 3.9 \text{ kip} \uparrow$, $d = 11.3 \text{ ft} \rightarrow$
4-159 $F_R = 13.2 \text{ lb} \downarrow$, $d = 0.340 \text{ ft} \rightarrow$
4-161 $w_1 = 190 \text{ lb/ft}$, $w_2 = 282 \text{ lb/ft}$
4-162 $w_2 = 17.2 \text{ kN/m}$, $w_1 = 30.3 \text{ kN/m}$
4-163 $F_R = 3.25 \text{ kip} \searrow 67.2^\circ$, $d = 3.86 \text{ ft} \uparrow$
4-165 $F_R = 3.1 \text{ kN} \downarrow$, $d = 2.06 \text{ m} \rightarrow$
4-166 $F_R = 1.8 \text{ kip} \downarrow$, $(M_R)_A = 4.2 \text{ kip} \cdot \text{ft} \curvearrowright$
4-167 $F_R = 1.8 \text{ kip} \downarrow$, $d = 2.33 \text{ ft} \rightarrow$
4-169 $F_R = 1.35 \text{ kN} \searrow 42.0^\circ$, $d = 0.556 \text{ m} \leftarrow$
4-170 $b = 5.62 \text{ m}$, $a = 1.54 \text{ m}$
4-171 $F_R = 1.25 \text{ kN} \downarrow$, $\bar{x} = 8 \text{ m} \rightarrow$
4-173 $F_R = 774 \text{ lb} \nwarrow$, $\bar{x} = 2.25 \text{ ft} \nearrow$
4-174 $F_R = 10.7 \text{ kN} \downarrow$, $\bar{x} = 1 \text{ m} \rightarrow$
4-175 $F_R = 53.3 \text{ lb} \downarrow$, $\bar{x} = 1.6 \text{ ft} \rightarrow$

Chapter 5

- 5-1** N/A
5-2 N/A
5-3 N/A
5-5 N/A
5-6 N/A

- 5-7** N/A
5-9 N/A
5-10 $B_y = 586 \text{ N}$, $F_A = 413 \text{ N}$
5-11 $N_A = 750 \text{ N}$, $B_y = 600 \text{ N}$, $B_x = 450 \text{ N}$
5-13 $N_A = 2.175 \text{ kN}$, $B_y = 1.875 \text{ kN}$, $B_x = 0$
5-14 $N_A = 3.33 \text{ kN}$, $B_x = 2.4 \text{ kN}$, $B_y = 133 \text{ N}$
5-15 $A_x = 0$, $A_y = 6.75 \text{ kN}$, $M_A = 46.2 \text{ kN} \cdot \text{m}$
5-17 $F_A = 30 \text{ lb}$, $F_B = 36.2 \text{ lb}$, $F_C = 9.38 \text{ lb}$
5-18 $N_B = 1.04 \text{ kN}$, $A_x = 0$, $A_y = 600 \text{ N}$
5-19 $T = 34.6 \text{ kN}$, $A_x = 20.8 \text{ kN}$, $A_y = 87.7 \text{ kN}$
5-21 $F_{CD} = 131 \text{ N}$, $B_x = 34.0 \text{ N}$, $B_y = 95.4 \text{ N}$
5-22 $F_{AB} = 38.3 \text{ kN (T)}$, $C_x = 30.7 \text{ kN}$, $C_y = 3.37 \text{ kN}$
5-23 $x_{\max} = 5.21 \text{ m}$, $C_x = 32 \text{ kN}$, $C_y = 4.38 \text{ kN}$
5-25 $N_C = 15 \text{ kip}$, $N_A = 15 \text{ kip}$, $N_B = 12 \text{ kip}$
5-26 $F_A = 432 \text{ lb}$, $F_B = 0$, $F_C = 432 \text{ lb}$
5-27 $N_B = 150 \text{ lb}$, $A_y = 300 \text{ lb}$, $A_x = 150 \text{ lb}$
5-29 $P = 27.7 \text{ lb}$
5-30 $\theta = 33.6^\circ$, $P_{\min} = 27.6 \text{ lb}$
5-31 N/A
5-33 $A_x = 25.4 \text{ kN}$, $B_y = 22.8 \text{ kN}$, $B_x = 25.4 \text{ kN}$
5-34 $F_{\max} = 14.0 \text{ kN}$
5-35 $N_B = 2.11 \text{ N}$, $F_A = 2.81 \text{ N}$
5-37 $A_y = 50 \text{ lb}$, $N_B = 1.6 \text{ kip}$, $A_x = 1.51 \text{ kip}$
5-38 $F = 93.8 \text{ lb}$, $A_x = 1.42 \text{ kip}$, $A_y = 46.9 \text{ lb}$
5-39 $\theta = 8.63^\circ$
5-41 $F_{BC} = 410 \text{ lb (C)}$, $A_x = 71.2 \text{ lb}$, $A_y = 396 \text{ lb}$
5-42 $F_{CB} = 782 \text{ N}$, $A_x = 625 \text{ N}$, $A_y = 681 \text{ N}$
5-43 $(F_2)_{\max} = 724 \text{ N}$, $(F_1)_{\max} = 1.45 \text{ kN}$,
 $(F_A)_{\max} = 1.75 \text{ kN}$
5-45 $d = 6 \text{ ft}$, $w = 267 \text{ lb/ft}$
5-46 $B_x = 989 \text{ N}$, $A_x = 989 \text{ N}$, $B_y = 186 \text{ N}$
5-47 $F_{\max} = 800 \text{ lb}$, $A_x = 540 \text{ lb}$, $A_y = 160 \text{ lb}$
5-49 $N_A = N_B = 180 \text{ lb}$, $h = 0.3 \text{ ft}$
5-50 $p = 662 \text{ psi}$
5-51 $N_C = 214 \text{ N}$, $N_A = N_B = 571 \text{ N}$
5-53 $T = \frac{W \cos \theta}{2 \sin(\phi - \theta)}$, $A_x = \frac{W \cos \phi \cos \theta}{2 \sin(\phi - \theta)}$,
 $A_y = \frac{W(\sin \phi \cos \theta - 2 \cos \phi \sin \theta)}{2 \sin(\phi - \theta)}$
5-54 $l_0 = 70.3 \text{ mm}$
5-55 $k = 11.2 \text{ lb/ft}$
5-57 $F_{BC} = 6.02 \text{ kip (C)}$, $A_x = 4.26 \text{ kip}$, $A_y = 3.66 \text{ kip}$
5-58 $P = \left\{ \frac{490 \cos \theta}{\sin(\theta/2 + 45^\circ)} \right\} \text{ N}$
5-59 $T = 9.08 \text{ lb}$
5-61 $R_C = 63.9 \text{ lb}$, $R_B = 11.9 \text{ lb}$, $R_A = 26.0 \text{ lb}$
5-62 $d = \frac{a}{\cos^3 \theta}$
5-63 $\theta = \tan^{-1} \left(\frac{l}{6\sqrt{a^2 - l^2/4}} \right)$

- 5-65** $A_x = -360 \text{ N}$, $A_y = -240 \text{ N}$, $A_z = 720 \text{ N}$,
 $M_{Ax} = 7.20 \text{ kN} \cdot \text{m}$, $M_{Ay} = -10.8 \text{ kN} \cdot \text{m}$,
 $M_{Az} = 0$
- 5-66** $F_A = 663 \text{ lb}$, $F_C = 569 \text{ lb}$, $F_B = 449 \text{ lb}$
- 5-67** $F = 368 \text{ N}$, $B_z = 401 \text{ N}$, $A_z = 334 \text{ N}$, $A_y = 0$,
 $B_x = -435 \text{ N}$, $A_x = 66.9 \text{ N}$
- 5-69** $A_x = -8 \text{ kN}$, $A_y = 0$, $A_z = -24.4 \text{ kN}$,
 $M_y = 20.0 \text{ kN} \cdot \text{m}$, $M_x = -572 \text{ kN} \cdot \text{m}$,
 $M_z = 64.0 \text{ kN} \cdot \text{m}$
- 5-70** $C_y = -318 \text{ N}$, $C_z = 500 \text{ N}$, $B_z = -273 \text{ N}$,
 $B_x = 239 \text{ N}$, $A_x = -239 \text{ N}$, $A_z = 90.9 \text{ N}$
- 5-71** $N_C = 0$, $W_{\max} = 451 \text{ lb}$, $N_A = N_B = 376 \text{ lb}$
- 5-73** $F_{BD} = F_{CD} = 62.4 \text{ lb}$, $A_z = 50.0 \text{ lb}$, $A_x = 33.3 \text{ lb}$,
 $A_y = 0$
- 5-74** $C_y = -800 \text{ N}$, $B_z = -107 \text{ N}$, $B_y = 600 \text{ N}$,
 $C_x = 53.6 \text{ N}$, $A_x = -400 \text{ N}$, $A_z = 800 \text{ N}$
- 5-75** $F_{DC} = 375 \text{ lb (C)}$, $E_x = 0$, $E_z = 562 \text{ lb}$, $A_x = 0$,
 $A_y = 0$, $A_z = 62.5 \text{ lb}$
- 5-77** $T_{BC} = 1.40 \text{ kN}$, $A_y = -800 \text{ N}$, $A_x = 1.20 \text{ kN}$,
 $(M_A)_x = -600 \text{ N} \cdot \text{m}$, $(M_A)_y = 1.20 \text{ kN} \cdot \text{m}$,
 $(M_A)_z = 2.40 \text{ kN} \cdot \text{m}$
- 5-78** $F_{CB} = 1.37 \text{ kN}$, $(M_A)_x = -785 \text{ N} \cdot \text{m}$,
 $(M_A)_z = 589 \text{ N} \cdot \text{m}$, $A_x = 1.18 \text{ kN}$, $A_y = 589 \text{ N}$,
 $A_z = 0$
- 5-79** $F_{CD} = 0$, $F_{EF} = 100 \text{ lb}$, $F_{BD} = 150 \text{ lb}$, $A_x = 0$,
 $A_y = 0$, $A_z = -50 \text{ lb}$
- 5-81** $F_{BC} = 175 \text{ lb}$, $A_x = 130 \text{ lb}$, $A_y = -10 \text{ lb}$,
 $M_{Ax} = -300 \text{ lb} \cdot \text{ft}$, $M_{Ay} = 0$, $M_{Az} = -720 \text{ lb} \cdot \text{ft}$
- 5-82** $F_{BC} = 105 \text{ lb}$
- 5-83** $B_y = -50 \text{ lb}$, $M_{Bz} = 0$, $M_{Bx} = -300 \text{ lb} \cdot \text{ft}$,
 $B_x = -16.7 \text{ lb}$, $A_x = 16.7 \text{ lb}$, $M_{By} = -900 \text{ lb} \cdot \text{ft}$,
 $B_z = 200 \text{ lb}$, $A_z = -200 \text{ lb}$
- 5-85** $F_{BD} = 294 \text{ N}$, $F_{BC} = 589 \text{ N}$, $A_x = 0$, $A_y = 589 \text{ N}$,
 $A_z = 490 \text{ N}$
- 5-86** $T_{DE} = 32.1 \text{ lb}$, $T_{BC} = 42.9 \text{ lb}$, $A_x = 3.57 \text{ lb}$,
 $A_y = 50 \text{ lb}$, $(M_A)_x = 0$, $(M_A)_y = -17.9 \text{ lb} \cdot \text{ft}$
- 5-87** $T = 58 \text{ N}$, $C_z = 77.6 \text{ N}$, $C_y = -24.9 \text{ N}$, $D_x = 0$,
 $D_y = -68.5 \text{ N}$, $D_z = 32.1 \text{ N}$
- 6-5** $F_{AE} = 8.94 \text{ kN (C)}$, $F_{AB} = 8 \text{ kN (T)}$,
 $F_{BC} = 8 \text{ kN (T)}$, $F_{BE} = 8 \text{ kN (C)}$,
 $F_{EC} = 8.94 \text{ kN (T)}$, $F_{ED} = 17.9 \text{ kN (C)}$,
 $F_{DC} = 8 \text{ kN (T)}$
- 6-6** $F_{AE} = 372 \text{ N (C)}$, $F_{AB} = 332 \text{ N (T)}$,
 $F_{BC} = 332 \text{ N (T)}$, $F_{BE} = 196 \text{ N (C)}$,
 $F_{EC} = 558 \text{ N (T)}$, $F_{ED} = 929 \text{ N (C)}$,
 $F_{DC} = 582 \text{ N (T)}$
- 6-7** $F_{GB} = 27.5 \text{ kN (T)}$, $F_{AF} = 15 \text{ kN (C)}$,
 $F_{AB} = 28.0 \text{ kN (C)}$, $F_{BF} = 25 \text{ kN (T)}$,
 $F_{BC} = 15 \text{ kN (T)}$, $F_{FC} = 21.2 \text{ kN (C)}$, $F_{FE} = 0$,
 $F_{ED} = 0$, $F_{EC} = 15 \text{ kN (T)}$, $F_{DC} = 0$
- 6-9** $F_{DF} = F_{BG} = 0$, $F_{CF} = F_{CG} = 0$, $F_{EF} = F_{AG} = 0$,
 $F_{BA} = F_{DE} = 667 \text{ lb (C)}$, $F_{BC} = F_{CD} = 667 \text{ lb (C)}$
- 6-10** $F_{BG} = 0$, $F_{GC} = 0$, $F_{GA} = 0$, $F_{DF} = 400 \text{ lb (C)}$,
 $F_{FC} = F_{FE} = 333 \text{ lb (T)}$, $F_{BC} = F_{BA} = 708 \text{ lb (C)}$,
 $F_{DC} = F_{DE} = 825 \text{ lb (C)}$
- 6-11** $F_{EF} = 0.667P \text{ (T)}$, $F_{FD} = 1.67P \text{ (T)}$,
 $F_{BA} = 0.471P \text{ (C)}$, $F_{AE} = 1.67P \text{ (T)}$,
 $F_{CA} = 1.49P \text{ (C)}$, $F_{FB} = 1.41P \text{ (T)}$,
 $F_{BD} = 1.49P \text{ (C)}$, $F_{EC} = 1.41P \text{ (T)}$,
 $F_{CD} = 0.471P \text{ (C)}$
- 6-13** $F_{CD} = F_{AD} = 0.687P \text{ (T)}$,
 $F_{CB} = F_{AB} = 0.943P \text{ (C)}$, $F_{DB} = 1.33P \text{ (T)}$
- 6-14** $P_{\max} = 848 \text{ lb}$
- 6-15** $P_{\max} = 848 \text{ lb}$
- 6-17** $P_{\max} = 5.19 \text{ kN}$
- 6-18** $F_{CB} = 3 \text{ kN (T)}$, $F_{CD} = 2.60 \text{ kN (C)}$,
 $F_{DE} = 2.60 \text{ kN (C)}$, $F_{DB} = 2 \text{ kN (T)}$,
 $F_{BE} = 2 \text{ kN (C)}$, $F_{BA} = 5 \text{ kN (T)}$
- 6-19** $F_{CB} = 8 \text{ kN (T)}$, $F_{CD} = 6.93 \text{ kN (C)}$,
 $F_{DE} = 6.93 \text{ kN (C)}$, $F_{DB} = 4 \text{ kN (T)}$,
 $F_{BE} = 4 \text{ kN (C)}$, $F_{BA} = 12 \text{ kN (T)}$
- 6-21** $F_{AB} = 43.8 \text{ kN (C)}$, $F_{AG} = 26.2 \text{ kN (T)}$,
 $F_{BC} = 26.2 \text{ kN (C)}$, $F_{BG} = 35 \text{ kN (T)}$
- 6-22** $F_{AB} = 7.5 \text{ kN (T)}$, $F_{AE} = 4.5 \text{ kN (C)}$,
 $F_{ED} = 4.5 \text{ kN (C)}$, $F_{EB} = 8 \text{ kN (T)}$,
 $F_{BD} = 19.8 \text{ kN (C)}$, $F_{BC} = 18.5 \text{ kN (T)}$
- 6-23** $F_{AB} = 3.75 \text{ kip (C)}$, $F_{AH} = 3 \text{ kip (T)}$,
 $F_{BC} = 3.75 \text{ kip (C)}$, $F_{BH} = 1 \text{ kip (C)}$,
 $F_{HC} = 1 \text{ kip (T)}$, $F_{GH} = 2 \text{ kip (T)}$,
 $F_{EF} = 3 \text{ kip (T)}$, $F_{ED} = 3.75 \text{ kip (C)}$,
 $F_{DC} = 3.75 \text{ kip (C)}$, $F_{DF} = 1 \text{ kip (C)}$,
 $F_{CF} = 1 \text{ kip (T)}$, $F_{CG} = 2 \text{ kip (C)}$,
 $F_{FG} = 2 \text{ kip (T)}$
- 6-25** $F_{BD} = 260 \text{ lb (C)}$, $F_{CD} = 480 \text{ lb (T)}$, $F_{AC} = 0$,
 $F_{AB} = 0$, $F_{BC} = 100 \text{ lb (T)}$
- 6-26** $(P_2)_{\max} = 134 \text{ lb}$
- 6-27** $F_{HI} = 42.5 \text{ kN (T)}$, $F_{HC} = 100 \text{ kN (T)}$,
 $F_{DC} = 125 \text{ kN (C)}$
- 6-29** $F_{GF} = 8.08 \text{ kN (T)}$, $F_{BC} = 7.70 \text{ kN (C)}$,
 $F_{CG} = 0.770 \text{ kN (C)}$

Chapter 6

- 6-1** $F_{AD} = 849 \text{ lb (C)}$, $F_{AB} = 600 \text{ lb (T)}$,
 $F_{BD} = 400 \text{ lb (C)}$, $F_{BC} = 600 \text{ lb (T)}$,
 $F_{DC} = 1.41 \text{ kip (T)}$, $F_{DE} = 1.60 \text{ kip (C)}$
- 6-2** $F_{AD} = 1.13 \text{ kip (C)}$, $F_{AB} = 800 \text{ lb (T)}$, $F_{BD} = 0$,
 $F_{BC} = 800 \text{ lb (T)}$, $F_{DC} = 1.13 \text{ kip (T)}$,
 $F_{DE} = 1.60 \text{ kip (C)}$
- 6-3** $F_{BA} = 214 \text{ lb (T)}$, $F_{BC} = 525 \text{ lb (C)}$,
 $F_{CA} = 371 \text{ lb (T)}$

- 6-30** $F_{FG} = 8.08 \text{ kN (T)}$, $F_{CD} = 8.47 \text{ kN (C)}$,
 $F_{CF} = 0.770 \text{ kN (T)}$
- 6-31** $F_{CD} = 50 \text{ kN (T)}$, $F_{HD} = 7.07 \text{ kN (C)}$,
 $F_{GD} = 5 \text{ kN (C)}$
- 6-33** $F_{HG} = 29.0 \text{ kN (C)}$, $F_{BC} = 20.5 \text{ kN (T)}$,
 $F_{HC} = 12.0 \text{ kN (T)}$
- 6-34** $F_{FE} = 1.80 \text{ kip (C)}$, $F_{EC} = 693 \text{ lb (C)}$
- 6-35** $F_{CB} = 3.60 \text{ kN (T)}$, $F_{GC} = 1.80 \text{ kN (C)}$,
 $F_{FG} = 4.02 \text{ kN (C)}$
- 6-37** $F_{LK} = 10 \text{ kip (C)}$, $F_{LC} = 2.5 \text{ kip (C)}$,
 $F_{BC} = 10 \text{ kip (T)}$
- 6-38** $F_{JI} = 7.33 \text{ kip (C)}$, $F_{DE} = 9 \text{ kip (T)}$,
 $F_{JE} = 3.00 \text{ kip (C)}$
- 6-39** $F_{FE} = 8.49 \text{ kN (T)}$, $F_{BC} = 8.49 \text{ kN (C)}$,
 $F_{FC} = 0$
- 6-41** $F_{JI} = 7.50 \text{ kip (T)}$, $F_{EI} = 2.50 \text{ kip (C)}$
- 6-42** $F_{KJ} = 3.07 \text{ kip (C)}$, $F_{CD} = 3.07 \text{ kip (T)}$,
 $F_{NJ} = 0.167 \text{ kip (C)}$
- 6-43** $F_{JI} = 2.13 \text{ kip (C)}$, $F_{DE} = 2.13 \text{ kip (T)}$
- 6-45** $F_{BF} = 0$, $F_{BG} = 35.4 \text{ kN (C)}$, $F_{AB} = 45 \text{ kN (T)}$
- 6-46** $F_{BG} = (200\sqrt{L^2 + 9}) \text{ N (C)}$,
 $F_{BC} = (200L) \text{ N (C)}$, $F_{HG} = (400L) \text{ N (T)}$
- 6-47** $F_{GF} = 1.78 \text{ kN (T)}$, $F_{CD} = 2.23 \text{ kN (C)}$, $F_{CF} = 0$
- 6-49** BN , NC , DO , OC , HJ , LE , and JG ,
 $F_{EF} = 7.88 \text{ kN (T)}$, $F_{LK} = 9.25 \text{ kN (C)}$,
 $F_{EP} = 1.94 \text{ kN (T)}$
- 6-50** $F_{AD} = 300 \text{ lb (C)}$, $F_{BD} = 450 \text{ lb (C)}$,
 $F_{CD} = 568 \text{ lb (C)}$
- 6-51** $F_{AB} = 6.46 \text{ kN (T)}$, $F_{AC} = F_{AD} = 1.50 \text{ kN (C)}$,
 $F_{BC} = F_{BD} = 3.70 \text{ kN (C)}$, $F_{BE} = 4.80 \text{ kN (T)}$
- 6-53** $F_{AE} = F_{AC} = 220 \text{ N (T)}$, $F_{AB} = 583 \text{ N (C)}$,
 $F_{BD} = 707 \text{ N (C)}$, $F_{BE} = F_{BC} = 141 \text{ N (T)}$
- 6-54** $F_{\max} = 169 \text{ N}$
- 6-55** $F_{BC} = 1.15 \text{ kN (C)}$, $F_{DF} = 4.16 \text{ kN (C)}$,
 $F_{BE} = 4.16 \text{ kN (T)}$
- 6-57** $F_{CD} = 650 \text{ lb (C)}$, $F_{CF} = 0$, $F_{DF} = 1.23 \text{ kip (T)}$,
 $F_{EF} = 525 \text{ lb (C)}$
- 6-58** $F_{AE} = 450 \text{ lb (T)}$, $F_{AB} = 300 \text{ lb (T)}$, $F_{BC} = 0$,
 $F_{BF} = 225 \text{ lb (T)}$, $F_{BE} = 515 \text{ lb (T)}$,
 $F_{BD} = 721 \text{ lb (C)}$
- 6-59** $F_{AD} = 686 \text{ N (T)}$, $F_{BD} = 0$, $F_{CD} = 615 \text{ N (C)}$,
 $F_{BC} = 229 \text{ N (T)}$, $F_{AC} = 343 \text{ N (T)}$,
 $F_{EC} = 457 \text{ N (C)}$
- 6-61** $P = 300 \text{ lb}$, $F_B = 580 \text{ lb}$
- 6-62** $P = 25 \text{ lb}$, $R_A = 25 \text{ lb}$, $R_B = 60 \text{ lb}$
- 6-63** $W_{\max} = 980 \text{ lb}$
- 6-65** $A_x = 300 \text{ N}$, $A_y = 300 \text{ N}$, $C_x = 300 \text{ N}$,
 $C_y = 300 \text{ N}$
- 6-66** $A_x = 80 \text{ lb}$, $A_y = 80 \text{ lb}$, $B_y = 133 \text{ lb}$, $B_x = 333 \text{ lb}$,
 $C_x = 413 \text{ lb}$, $C_y = 53.3 \text{ lb}$
- 6-67** $P_{\max} = 742$
- 6-69** $D_x = 0$, $D_y = 5 \text{ kN}$, $A_x = 0$, $A_y = 17 \text{ kN}$,
 $M_A = 32 \text{ kN} \cdot \text{m}$
- 6-70** $C_x = D_x = 160 \text{ lb}$, $C_y = D_y = 107 \text{ lb}$,
 $B_y = 26.7 \text{ lb}$, $B_x = 80 \text{ lb}$, $E_x = 0$, $E_y = 26.7 \text{ lb}$,
 $A_x = 160 \text{ lb}$
- 6-71** $M = 2.43 \text{ kN} \cdot \text{m}$
- 6-73** $F_{AC} = 2.51 \text{ kip (C)}$, $F_{AB} = 3.08 \text{ kip (C)}$,
 $F_{AD} = 3.43 \text{ kip (T)}$
- 6-74** $A_y = 245 \text{ N}$, $D_y = 245 \text{ N}$, $D_x = 695 \text{ N}$,
 $A_x = 695 \text{ N}$
- 6-75** $F_{CD} = 1.01 \text{ kN}$, $F_{ABC} = 319 \text{ N}$
- 6-77** $A_x = 300 \text{ lb}$, $A_y = 400 \text{ lb}$, $C_y = 1.2 \text{ kip}$,
 $D_x = 300 \text{ lb}$, $D_y = 800 \text{ lb}$
- 6-78** $N_A = 8 \text{ kip}$, $N_C = 5.14 \text{ kip}$, $N_B = 14.9 \text{ kip}$
- 6-79** $C_y = 1.33 \text{ kN}$, $B_y = 549 \text{ N}$, $C_x = 2.98 \text{ kN}$,
 $A_y = 235 \text{ N}$, $A_x = 2.98 \text{ kN}$, $B_x = 2.98 \text{ kN}$
- 6-81** $F_{IJ} = 9.06 \text{ kN (T)}$, $F_{BC} = 15.4 \text{ kN (C)}$
- 6-82** $C_y = 5 \text{ kN}$, $B_y = 15 \text{ kN}$, $M_A = 30 \text{ kN} \cdot \text{m}$,
 $A_y = 5 \text{ kN}$, $A_x = 0$
- 6-83** $D_x = 50 \text{ lb}$, $D_y = 50 \text{ lb}$, $B_x = 112 \text{ lb}$,
 $A_x = 62.5 \text{ lb}$, $B_y = 117 \text{ lb}$, $A_y = 167 \text{ lb}$
- 6-85** $P = 107 \text{ N}$
- 6-86** $W_S = 3.35 \text{ lb}$, No
- 6-87** $C_x = 75 \text{ lb}$, $C_y = 100 \text{ lb}$
- 6-89** $A_x = 4.20 \text{ kN}$, $B_x = 4.20 \text{ kN}$, $A_y = 4.00 \text{ kN}$,
 $B_y = 3.20 \text{ kN}$, $C_x = 3.40 \text{ kN}$, $C_y = 4.00 \text{ kN}$
- 6-90** $P = 2 \text{ lb}$
- 6-91** $F = 120 \text{ lb}$
- 6-93** $T = 5.10 \text{ kN}$, $\theta = 30^\circ$, $A_x = 4.33 \text{ kN}$,
 $A_y = 5.15 \text{ kN}$
- 6-94** $\theta = 33.7^\circ$, $s = 177 \text{ mm}$
- 6-95** $F_N = 5.25 \text{ lb}$
- 6-97** $P = 40 \text{ N}$, $x = 240 \text{ mm}$
- 6-98** $N_E = 5 \text{ kN}$, $N_C = 16.7 \text{ kN}$, $A_x = 0$,
 $A_y = 2.67 \text{ kN}$, $M_A = 21.5 \text{ kN} \cdot \text{m}$
- 6-99** $N_C = 12.7 \text{ kN}$, $A_x = 12.7 \text{ kN}$, $A_y = 2.94 \text{ kN}$,
 $N_D = 1.05 \text{ kN}$
- 6-101** $F_{AB} = 8.60 \text{ MN (C)}$, $F_C = 9.78 \text{ MN}$
- 6-102** $A_y = 34.0 \text{ N}$, $A_x = 0$, $C_y = 6.54 \text{ N}$, $C_x = 0$,
 $x = 292 \text{ mm}$, $B_y = 1.06 \text{ N}$, $B_x = 0$
- 6-103** $F = 562 \text{ N}$
- 6-105** $F = 6.93 \text{ kN}$
- 6-106** $F_s = 286 \text{ N}$
- 6-107** $d_{\min} = 0.638 \text{ ft}$
- 6-109** $F_E = 3.64F$
- 6-110** $\theta = 6.22^\circ$
- 6-111** $W = 25.5 \text{ lb}$
- 6-113** $m_S = 1.71 \text{ kg}$
- 6-114** $m_L = 106 \text{ kg}$
- 6-115** $P_{\max} = 282 \text{ N}$, $B_x = D_x = 70.7 \text{ N}$,
 $B_y = D_y = 283 \text{ N}$, $B_z = D_z = 283 \text{ N}$

- 6-117** $F_{AB} = 1.56 \text{ kN}$, $E_x = 0$, $E_y = 0$,
 $M_{Ex} = 0.5 \text{ kN} \cdot \text{m}$, $M_{Ey} = 0$
- 6-118** $M_{Cx} = 0$, $C_x = 0$, $C_z = 0.18 \text{ kip}$, $C_y = 1.17 \text{ kip}$,
 $M_{Cz} = 4.14 \text{ kip} \cdot \text{ft}$, $A_x = 0$, $A_y = 1.44 \text{ kip}$,
 $A_z = 0.540 \text{ kip}$

Chapter 7

- 7-1** $N_C = 0$, $V_C = -1 \text{ kip}$, $M_C = 56 \text{ kip} \cdot \text{ft}$, $N_D = 0$,
 $V_D = -1 \text{ kip}$, $M_D = 48 \text{ kip} \cdot \text{ft}$
- 7-2** $N_B = 0$, $V_B = -100 \text{ lb}$, $M_B = 750 \text{ lb} \cdot \text{in.}$,
 $N_D = 0$, $V_D = 75 \text{ lb}$, $M_D = -750 \text{ lb} \cdot \text{in.}$
- 7-3** $N_A = -39 \text{ kN}$, $V_A = 0$, $M_A = -2.42 \text{ kN} \cdot \text{m}$
- 7-5** $N_C = 21.7 \text{ kN}$, $V_C = 62.5 \text{ kN}$, $M_C = -225 \text{ kN} \cdot \text{m}$
- 7-6** $N_D = 0$, $V_D = 8 \text{ kN}$, $M_D = -9.75 \text{ kN} \cdot \text{m}$,
 $N_E = 0$, $V_E = 5 \text{ kN}$, $M_E = 7.5 \text{ kN} \cdot \text{m}$
- 7-7** $N_C = 0$, $V_C = 2.88 \text{ kN}$, $M_C = 6.56 \text{ kN} \cdot \text{m}$,
 $N_D = 0$, $V_D = 1.75 \text{ kN}$, $M_D = 9.75 \text{ kN} \cdot \text{m}$
- 7-9** $N_E = 470 \text{ N}$, $V_E = 215 \text{ N}$, $M_E = 660 \text{ N} \cdot \text{m}$,
 $N_F = 0$, $V_F = -215 \text{ N}$, $M_F = 660 \text{ N} \cdot \text{m}$
- 7-10** $N_C = 0$, $V_C = 0.5 \text{ kip}$, $M_C = 3.6 \text{ kip} \cdot \text{ft}$
- 7-11** $N_C = 0$, $V_C = 0$, $M_C = 1.5 \text{ kN} \cdot \text{m}$
- 7-13** $N_C = 0$, $V_C = \frac{3w_0L}{8}$, $M_C = -\frac{5}{48}w_0L^2$
- 7-14** $N_C = -1.80 \text{ kip}$, $V_C = -125 \text{ lb}$, $M_C = 9.75 \text{ kip} \cdot \text{ft}$
- 7-15** $M_C = -15 \text{ kip} \cdot \text{ft}$, $N_C = 0$, $V_C = 2.01 \text{ kip}$,
 $M_D = 3.77 \text{ kip} \cdot \text{ft}$, $N_D = 0$, $V_D = 1.11 \text{ kip}$
- 7-17** $N_A = 86.6 \text{ lb}$, $V_A = 150 \text{ lb}$, $M_A = 1.8 \text{ kip} \cdot \text{in.}$
- 7-18** $N_C = -4 \text{ kip}$, $V_C = -1 \text{ kip}$, $M_C = -14 \text{ kip} \cdot \text{ft}$,
 $N_D = -4 \text{ kip}$, $V_D = 1.75 \text{ kip}$, $M_D = -5 \text{ kip} \cdot \text{ft}$
- 7-19** $N_E = -1.92 \text{ kN}$, $V_E = 800 \text{ N}$, $M_E = 2.4 \text{ kN} \cdot \text{m}$
- 7-21** $N_C = -4.32 \text{ kip}$, $V_C = 1.35 \text{ kip}$, $M_C = 4.72 \text{ kip} \cdot \text{ft}$
- 7-22** $N_D = 0$, $V_D = 5 \text{ kip}$, $M_D = 46 \text{ kip} \cdot \text{ft}$
- 7-23** $N_C = -\frac{wL}{2} \csc \theta$, $V_C = 0$, $M_C = \frac{wL^2}{8} \cos \theta$
- 7-25** $N_C = -265 \text{ lb}$, $V_C = -649 \text{ lb}$,
 $M_C = -4.23 \text{ kip} \cdot \text{ft}$, $N_D = -265 \text{ lb}$, $V_D = 637 \text{ lb}$,
 $M_D = -3.18 \text{ kip} \cdot \text{ft}$
- 7-26** $a = \frac{L}{3}$
- 7-27** $N_C = -1.91 \text{ kN}$, $V_C = 0$, $M_C = 382 \text{ N} \cdot \text{m}$
- 7-29** $N_C = -406 \text{ lb}$, $V_C = 903 \text{ lb}$, $M_C = 1.35 \text{ kip} \cdot \text{ft}$
- 7-30** $N_D = -464 \text{ lb}$, $V_D = -203 \text{ lb}$, $M_D = 2.61 \text{ kip} \cdot \text{ft}$
- 7-31** $V_D = 0$, $N_D = 200 \text{ lb}$, $M_D = 900 \text{ lb} \cdot \text{ft}$,
 $V_E = 120 \text{ lb}$, $N_E = 360 \text{ lb}$, $M_E = 1.14 \text{ kip} \cdot \text{ft}$
- 7-33** $N_D = -450 \text{ lb}$, $V_D = 250 \text{ lb}$, $M_D = -750 \text{ lb} \cdot \text{ft}$
- 7-34** $N_E = 250 \text{ lb}$, $V_E = 0$, $M_E = 675 \text{ lb} \cdot \text{ft}$
- 7-35** $V_{Ax} = 0$, $N_{Ay} = 0$, $V_{Az} = 250 \text{ lb}$,
 $M_{Ax} = 188 \text{ lb} \cdot \text{ft}$, $M_{Ay} = 188 \text{ lb} \cdot \text{ft}$, $M_{Az} = 0$,
 $V_{Bx} = 0$, $V_{By} = 0$, $N_{Bz} = 250 \text{ lb}$,
 $M_{Bx} = 438 \text{ lb} \cdot \text{ft}$, $M_{By} = 188 \text{ lb} \cdot \text{ft}$, $M_{Bz} = 0$
- 7-37** $V = -0.293rw_0$, $N = -0.707rw_0$,
 $M = 0.0783 r^2w_0$
- 7-38** $N = -0.866rw_0$, $V = -1.5rw_0$, $M = 1.23r^2w_0$
- 7-39** $V = 0.278rw_0$, $N = 0.0759rw_0$, $M = 0.0759r^2w_0$
- 7-41** $V_D = 135 \text{ N}$, $N_D = 180 \text{ N}$, $M_D = 270 \text{ N} \cdot \text{m}$
- 7-42** $(V_C)_x = 450 \text{ N}$, $(N_C)_y = 0$, $(V_C)_z = -550 \text{ N}$,
 $(M_C)_x = -825 \text{ N} \cdot \text{m}$, $(M_C)_y = 30 \text{ N} \cdot \text{m}$,
 $(M_C)_z = 675 \text{ N} \cdot \text{m}$
- 7-43** $(V_D)_x = 116 \text{ kN}$, $(N_D)_y = -65.6 \text{ kN}$, $(V_D)_z = 0$,
 $(M_D)_x = 49.2 \text{ kN} \cdot \text{m}$, $(M_D)_y = 87 \text{ kN} \cdot \text{m}$,
 $(M_D)_z = 26.2 \text{ kN} \cdot \text{m}$
- 7-45** a) $0 \leq x < a$: $V = \left(1 - \frac{a}{L}\right)P$
 $M = \left(1 - \frac{a}{L}\right)Px$
 $a < x \leq L$: $V = -\left(\frac{a}{L}\right)P$
 $M = P\left(a - \frac{a}{L}x\right)$
b) $0 \leq x < 2 \text{ m}$: $V = 6 \text{ kN}$, $M = \{6x\} \text{ kN} \cdot \text{m}$
 $2 \text{ m} < x \leq 6 \text{ m}$: $V = -3 \text{ kN}$
 $M = \{18 - 3x\} \text{ kN} \cdot \text{m}$
- 7-46** a) For $0 \leq x < a$, $V = P$, $M = Px$
For $a < x < L - a$, $V = 0$, $M = Pa$
For $L - a < x \leq L$, $V = -P$,
 $M = P(L - x)$, b) For $0 \leq x < 5 \text{ ft}$,
 $V = 800 \text{ lb}$, $M = \{800x\} \text{ lb} \cdot \text{ft}$
For $5 \text{ ft} < x < 7 \text{ ft}$, $V = 0$, $M = 4 \text{ kip} \cdot \text{ft}$
For $7 \text{ ft} < x \leq 12 \text{ ft}$, $V = -800 \text{ lb}$
 $M = \{9.6 - 0.8x\} \text{ kip} \cdot \text{ft}$
- 7-47** a) For $0 \leq x < a$, $V = \frac{Pb}{a+b}$, $M = \frac{Pb}{a+b}x$
For $a < x \leq a+b$, $V = -\frac{Pa}{a+b}$
 $M = Pa - \frac{Pa}{a+b}x$,
b) For $0 \leq x < 5 \text{ ft}$, $V = 350 \text{ lb}$
 $M = \{350x\} \text{ lb} \cdot \text{ft}$
For $5 \text{ ft} < x \leq 12 \text{ ft}$, $V = -250 \text{ lb}$
 $M = \{3 - 0.25x\} \text{ kip} \cdot \text{ft}$
- 7-49** For $0 \leq x < b$, $V = -Pa/b$, $M = -Pax/b$,
For $b < x \leq a+b$, $V = P$, $M = -P(a+b-x)$
- 7-50** $V = \{4 - 2x\} \text{ kN}$, $M = \{-x^2 + 4x - 10\} \text{ kN} \cdot \text{m}$
- 7-51** $V = \{28 - 3x\} \text{ kN}$,
 $M = \{28x - 1.5x^2 - 114\} \text{ kN} \cdot \text{m}$
- 7-53** For $0 \leq x < 8 \text{ m}$, $V = \{134 - 40x\} \text{ kN}$,
 $M = \{134x - 20x^2\} \text{ kN} \cdot \text{m}$, For $8 \text{ m} < x \leq 11 \text{ m}$,
 $V = 20 \text{ kN}$, $M = \{20x - 370\} \text{ kN} \cdot \text{m}$
- 7-54** $(w_0)_{\max} = 8.52 \text{ kN/m}$

- 7-55** For $0 \leq x < L$, $V = \frac{w}{18}(7L - 18x)$,
 $M = \frac{w}{18}(7Lx - 9x^2)$, For $L < x < 2L$,
 $V = \frac{w}{2}(3L - 2x)$, $M = \frac{w}{18}(27Lx - 20L^2 - 9x^2)$,
For $2L < x \leq 3L$, $V = \frac{w}{18}(47L - 18x)$,
 $M = \frac{w}{18}(47Lx - 9x^2 - 60L^2)$
- 7-57** a) $V = \frac{w}{8}(7L - 8x)$
 $M = -\frac{w}{8}(4x^2 - 7Lx + 3L^2)$,
b) $V = \{5(10.5 - x)\} \text{ kN}$
 $M = \{-2.5(x^2 - 21x + 108)\} \text{ kN} \cdot \text{m}$
- 7-58** $V = \frac{w}{4}(3L - 4x)$, $M = \frac{w}{4}(3Lx - 2x^2 - L^2)$
- 7-59** For $0 \leq x < 3 \text{ m}$, $V = \{-2x^2/3 - 4\} \text{ kN}$,
 $M = \{-2x^3/9 - 4x\} \text{ kN} \cdot \text{m}$,
For $3 \text{ m} < x \leq 6 \text{ m}$, $V = \{4(6 - x)\} \text{ kN}$,
 $M = \{-2(6 - x)^2\} \text{ kN} \cdot \text{m}$
- 7-61** For $0 \leq x < 15 \text{ ft}$, $V = -20 \text{ kip}$,
 $M = \{-20x\} \text{ kip} \cdot \text{ft}$,
For $15 \text{ ft} < x < 45 \text{ ft}$, $V = \{120 - 4x\} \text{ kip}$,
 $M = \{-1.65(10^3) + 120x - 2x^2\} \text{ kip} \cdot \text{ft}$,
For $45 \text{ ft} < x \leq 60 \text{ ft}$, $V = 20 \text{ kip}$,
 $M = \{-1.2(10^3) + 20x\} \text{ kip} \cdot \text{ft}$
- 7-62** $a = \frac{L}{\sqrt{2}}$
- 7-63** $(w_0)_{\max} = 21.7 \text{ lb/ft}$
- 7-65** $V = \{3 - 0.5x\} \text{ kip}$,
 $M = \{3x - 0.25x^2 - 6.75\} \text{ kip} \cdot \text{ft}$
- 7-66** $V_x = 0$, $V_z = \{24 - 4y\} \text{ lb}$,
 $M_x = \{2y^2 - 24y + 64\} \text{ lb} \cdot \text{ft}$, $M_y = 8 \text{ lb} \cdot \text{ft}$,
 $M_z = 0$
- 7-67** $V = \frac{\pi \gamma r_0^2}{3L^2}[(L + x)^3 - L^3]$,
 $M = -\frac{\pi \gamma r_0^2}{12L^2}[(L + x)^4 - L^3(4x + L)]$
- 7-69** $V = \{16 - 4y\} \text{ lb}$, $M = \{-2y^2 + 16y - 40\} \text{ lb} \cdot \text{ft}$
- 7-70** $V_{\max} = 675 \text{ lb}$, $M_{\max} = 1.9 \text{ kip} \cdot \text{ft}$
- 7-71** $V_{\max} = -14.5 \text{ kN}$, $M_{\max} = -22 \text{ kN} \cdot \text{m}$
- 7-73** $V_{\max} = \pm 5 \text{ kN}$, $M_{\max} = -10 \text{ kN} \cdot \text{m}$
- 7-74** $V_{\max} = -225 \text{ lb}$, $M_{\max} = -300 \text{ lb} \cdot \text{ft}$
- 7-75** $V_{\max} = 625 \text{ N}$, $M_{\max} = 750 \text{ N} \cdot \text{m}$
- 7-77** $V_{\max} = -14 \text{ kN}$, $M_{\max} = 18 \text{ kN} \cdot \text{m}$
- 7-78** $V_{\max} = 45 \text{ kN}$, $M_{\max} = -67.5 \text{ kN} \cdot \text{m}$
- 7-79** $V_{\max} = -2P$, $M_{\max} = PL$
- 7-81** $V_{\max} = 800 \text{ lb}$, $M_{\max} = -1.2 \text{ kip} \cdot \text{ft}$
- 7-82** $V_{\max} = 28 \text{ kN}$, $M_{\max} = -114 \text{ kN} \cdot \text{m}$
- 7-83** $V_{\max} = -10.5 \text{ kN}$, $M_{\max} = 22.6 \text{ kN} \cdot \text{m}$
- 7-85** $V_{\max} = -110 \text{ lb}$, $M_{\max} = -180 \text{ lb} \cdot \text{ft}$
- 7-86** $V_{\max} = \pm 3 \text{ kN}$, $M_{\max} = 3 \text{ kN} \cdot \text{m}$

- 7-87** $V_{\max} = -15.8 \text{ kN}$, $M_{\max} = 20.5 \text{ kN} \cdot \text{m}$
- 7-89** $V_{\max} = \pm 20 \text{ kN}$, $M_{\max} = 45 \text{ kN} \cdot \text{m}$
- 7-90** $V_{\max} = \pm 11.5 \text{ kN}$, $M_{\max} = -21 \text{ kN} \cdot \text{m}$
- 7-91** $V_{\max} = -172 \text{ lb}$, $M_{\max} = -200 \text{ lb} \cdot \text{ft}$
- 7-93** $V_{\max} = 3.75 \text{ kip}$, $M_{\max} = 37.5 \text{ kip} \cdot \text{ft}$
- 7-94** $x_B = 4.36 \text{ ft}$
- 7-95** $P = 71.4 \text{ lb}$
- 7-97** $x_B = 3.98 \text{ ft}$
- 7-98** $P = 84 \text{ lb}$
- 7-99** $y_B = 8.67 \text{ ft}$, $y_D = 7.04 \text{ ft}$
- 7-101** $h = 2.68 \text{ ft}$, $\mathcal{L} = 13.4 \text{ ft}$
- 7-102** $w_{\max} = 51.9 \text{ lb/ft}$
- 7-103** $T_{\max} = 14.4 \text{ kip}$, $T_{\min} = 13.0 \text{ kip}$
- 7-105** $T_B = 48.7 \text{ MN}$, $T_A = 51.4 \text{ MN}$
- 7-106** $(w_0)_{\max} = 77.8 \text{ kN/m}$
- 7-107** $y = \{46.0(10^{-6})x^3 + 0.176x\} \text{ ft}$, $T_{\max} = 48.7 \text{ kip}$
- 7-109** $T_{\max} = 594 \text{ kN}$
- 7-110** $T_{\min} = 552 \text{ kN}$
- 7-111** $h_{\min} = 7.09 \text{ m}$
- 7-113** $y = \{137[\cosh 7.32(10^{-3})x - 1]\} \text{ ft}$, $\mathcal{L} = 158 \text{ ft}$
- 7-114** $T_{\max} = 5.36 \text{ kN}$, $\mathcal{L} = 51.3 \text{ m}$
- 7-115** $y = \{23.5[\cosh 0.0425x - 1]\} \text{ m}$, $T_{\max} = 1.60 \text{ kN}$
- 7-117** $d_{AC} = 8.07 \text{ m}$
- 7-118** N/A
- 7-119** $F_{Rx} = 292 \text{ lb}$
- 7-121** $s = 5.14 \text{ ft}$
- 7-122** $T_{\max} = 4.52 \text{ kip}$, $\mathcal{L} = 331 \text{ ft}$

Chapter 8

- 8-1** $P_{\max} = 12.8 \text{ kN}$
- 8-2** $P = 76.0 \text{ lb}$
- 8-3** $N_A = 16.5 \text{ kN}$, $N_B = 42.3 \text{ kN}$, No
- 8-5** $P = 140 \text{ N}$, $d = 500 \text{ mm}$
- 8-6** $F_C = 30.5 \text{ N}$, $N_C = 152 \text{ N}$, $x = 0.794 \text{ m}$
- 8-7** $b = 2a \sin \theta$
- 8-9** N/A
- 8-10** $\phi = \theta_k$, $P_{\min} = W \sin(\alpha + \theta_k)$
- 8-11** $P = 0.990 \text{ lb}$
- 8-13** $F_A = 604 \text{ N}$, No
- 8-14** $\theta_{\max} = 21.8^\circ$
- 8-15** $l = 26.7 \text{ ft}$
- 8-17** $(\mu_A)_{\min} = (\mu_B)_{\min} = 0.268$
- 8-18** $\theta_{\max} = 15.9^\circ$
- 8-19** $(\mu_s)_{\min} = 0.578$
- 8-21** $n_{\max} = 8$
- 8-22** $s = 5 \text{ in.}$
- 8-23** $P_{\min} = 1.18 \text{ kN}$
- 8-25** Yes., It slips.
- 8-26** It will slip.
- 8-27** It will slip.

- 8-29** $\mu_s = 0.306$
8-30 $P_{\min} = 1.03 \text{ kN}$
8-31 $P_{\min} = 845 \text{ N}$
8-33 No
8-34 At $P = \frac{W}{2}$ $\mu_s = 0.333$,
 For $0 < P < \frac{W}{2}$ and $\frac{W}{2} < P \leq W$,

$$\mu_s = \frac{(P + W) - \sqrt{(W + 7P)(W - P)}}{2(2P - W)}$$

8-35 $P_{\max} = 8.18 \text{ lb}$
8-37 $M_{\max} = 77.2 \text{ N} \cdot \text{m}$
8-38 $F_A = 71.4 \text{ N}$
8-39 No
8-41 $n_{\max} = 7$
8-42 $F_B = 200 \text{ N}$
8-43 $\mu_{\min} = 0.177$
8-45 $d_{\max} = 2.7 \text{ in.}$
8-46 $P_{\min} = 613 \text{ N}$
8-47 $P_{\min} = 13.4 \text{ lb}$
8-49 $P_{\min} = 589 \text{ N}$
8-50 $(\mu_A)_{\max} = 0.152$, $(\mu_B)_{\max} = 0.254$
8-51 $P_{\min} = 49.1 \text{ N}$
8-53 $P_{\min} = 83.4 \text{ lb}$
8-54 $P_{\min} = 100 \text{ lb}$
8-55 $d_{\max} = \frac{2\mu_s l}{\sqrt{1 + 4\mu_s^2}}$
8-57 $P_{\min} = \frac{2}{3}\mu_s W$
8-58 $\theta_{\max} = 33.3^\circ$
8-59 $\theta_{\max} = 22.6^\circ$
8-61 $P_{\min} = 858 \text{ N}$
8-62 $P_{\max} = 0.0328W$
8-63 $P_{\min} = 1.38W$
8-65 $P_{\min} = 304 \text{ N}$
8-66 $s_{\min} = 32.9 \text{ mm}$
8-67 $F = 66.7 \text{ N}$
8-69 $P_{\min} = 575 \text{ N}$
8-70 $\theta_{\max} = 33.3^\circ$
8-71 $F = 71.4 \text{ N}$
8-73 N/A
8-74 $M = 40.6 \text{ N} \cdot \text{m}$
8-75 $\mu_s = 0.0637$
8-77 $P = 51.2 \text{ N}$
8-78 $P = 880 \text{ N}$, $M_{\max} = 351 \text{ N} \cdot \text{m}$
8-79 $P = 617 \text{ lb}$
8-81 $F = 4.91 \text{ N}$
8-82 $P = 2.85 \text{ kN}$
8-83 $(W_D)_{\max} = 12.7 \text{ lb}$
8-85 $n_{\min} = 2$
8-86 $P = 1.54 \text{ kN}$
8-87 $\mu_s = 0.0583$
8-89 $(T_A)_{\min} = 1.95 \text{ kN}$, $(T_B)_{\min} = 759 \text{ N}$
8-90 $P_{\min} = 736 \text{ N}$
8-91 $\theta = 40.1^\circ$
8-93 $M_{\max} = 458 \text{ N} \cdot \text{m}$
8-94 $(m_D)_{\max} = 25.5 \text{ kg}$
8-95 $F_A = 16.2 \text{ N}$, No
8-97 $n_{\max} = 30$, $M = 150 \text{ lb} \cdot \text{ft}$
8-98 N/A
8-99 $P_{\min} = 53.6 \text{ N}$
8-101 $W_{\max} = 39.5 \text{ lb}$
8-102 $T_1 = 1.85 \text{ N}$, $T_2 = 1.59 \text{ N}$
8-103 $n_{\min} = 2$
8-105 $\theta_{\max} = 38.7^\circ$
8-106 $d = 4.07 \text{ m}$, $(\mu_s)_{\min} = 0.190$
8-107 $M = 304 \text{ lb} \cdot \text{in.}$
8-109 $M = 97.5 \text{ lb} \cdot \text{ft}$
8-110 $F_s = 1.62 \text{ kip}$
8-111 $M_{\min} = 238 \text{ N} \cdot \text{m}$
8-113 $M = \frac{\mu_s P}{3 \cos \theta} \left(\frac{d_2^3}{d_2^2 - d_1^2} - d_1^3 \right)$
8-114 $p_0 = 0.442 \text{ psi}$, $F_{\min} = 573 \text{ lb}$
8-115 $P_{\min} = 2.00 \text{ N}$
8-117 $P = 814 \text{ N}$
8-118 $P_{\min} = 0.590 \text{ lb}$, $P_{\min} \approx 0.597 \text{ lb}$
8-119 $M = \frac{\mu_k P r}{\sqrt{1 + \mu_k^2}}$
8-121 $m_B = 13.2 \text{ kg}$
8-122 $(r_f)_A \approx 0.2 \text{ in.}$, $(r_f)_B \approx 0.075 \text{ in.}$
8-123 $(r_f)_A \approx 7.5 \text{ mm}$, $(r_f)_B \approx 3 \text{ mm}$
8-125 $P = 1.88 \text{ lb}$, $P \approx 1.89 \text{ lb}$
8-126 $P_{\min} = 216 \text{ N}$
8-127 $P_{\max} = 178 \text{ N}$
8-129 $P_{\max} = 266 \text{ N}$
8-130 N/A
8-131 $P_{\min} = 33.4 \text{ lb}$

Chapter 9

- 9-1** $\bar{x} = 0.546 \text{ m}$, $O_x = 0$, $O_y = 7.06 \text{ N}$,
 $M_O = 3.85 \text{ N} \cdot \text{m}$
9-2 $\bar{x} = 0$, $\bar{y} = 1.82 \text{ ft}$
9-3 $\bar{x} = 0.574 \text{ m}$, $B_x = 0$, $B_y = 84.8 \text{ N}$,
 $A_y = 63.1 \text{ N}$
9-5 $m = 13.9 \text{ kg}$, $\bar{x} = 1.24 \text{ m}$, $\bar{y} = 2.18 \text{ m}$
9-6 $A = 2.25 \text{ ft}^2$, $\bar{x} = 2.4 \text{ ft}$, $\bar{y} = 0.857 \text{ ft}$
9-7 $A = \frac{2}{3}ah$, $\bar{x} = \frac{3}{8}a$, $\bar{y} = \frac{3}{5}h$
9-9 $\bar{x} = 0.649 \text{ ft}$
9-10 $\bar{y} = 2.04 \text{ ft}$

- 9-11** $\bar{x} = \frac{3}{4}b$
9-13 $\bar{x} = \left(\frac{\pi - 2}{2\pi}\right)a$
9-14 $\bar{y} = \frac{\pi a}{8}$
9-15 $\bar{x} = 1.08 \text{ in.}$
9-17 $\bar{y} = \frac{a\pi}{8}, \bar{x} = \frac{L}{2}$
9-18 $\bar{x} = 0.398 \text{ m}$
9-19 $\bar{y} = 1.00 \text{ m}$
9-21 $\bar{x} = 1.6 \text{ ft}$
9-22 $\bar{y} = 4.15 \text{ ft}$
9-23 $\bar{x} = 0.4 \text{ ft}$
9-25 $\bar{x} = 3.20 \text{ ft}, \bar{y} = 3.20 \text{ ft}, \bar{z} = -0.125 \text{ ft},$
 $T_A = 384 \text{ lb}, T_C = 384 \text{ lb}, T_B = 1.15 \text{ kip}$
9-26 $\bar{y} = \frac{4b}{3\pi}, \bar{x} = \frac{4a}{3\pi}$
9-27 $\bar{y} = 2.80 \text{ m}, \bar{x} = 6.00 \text{ m}$
9-29 $\bar{y} = 1.33 \text{ in.}$
9-30 $\bar{x} = 1 \text{ m}$
9-31 $\bar{y} = 0.4 \text{ m}$
9-33 $\bar{y} = \frac{\pi a}{8}$
9-34 $\bar{x} = -3 \text{ m}, \bar{y} = 0.25 \text{ m}, \bar{z} = -0.3 \text{ m},$
 $A_z = 52.3 \text{ kN}, M_{Ay} = 52.3 \text{ kN} \cdot \text{m},$
 $A_z - 52.3 = 0, A_z = 52.3 \text{ kN}, M_A = 52.3 \text{ kN} \cdot \text{m}$
9-35 $\bar{x} = 0.446 \text{ m}$
9-37 $\bar{y} = \frac{3}{4}h$
9-38 $\bar{y} = \frac{4}{5}h$
9-39 $\bar{y} = \frac{2}{5}h$
9-41 $\bar{x} = \bar{y} = 0, \bar{z} = \frac{2}{3}a$
9-42 $\bar{z} = \frac{R^2 + 3r^2 + 2rR}{4(R^2 + r^2 + rR)}h$
9-43 $\bar{z} = 2.50 \text{ ft}$
9-45 $\bar{y} = 0.833 \text{ ft}$
9-46 $\bar{y} = \frac{3}{8}a$
9-47 $\bar{y} = 16.9 \text{ in.}$
9-49 $m = 0.917\pi\rho_0a^3, \bar{y} = 0.418a$
9-50 $\bar{z} = \frac{c}{4}$
9-51 $\bar{x} = 34.4 \text{ mm}, \bar{y} = 85.8 \text{ mm}$
9-53 $\bar{x} = -0.590 \text{ in.}, \bar{y} = 1.07 \text{ in.}, \bar{z} = 2.14 \text{ in.}$
9-54 $\bar{x} = -50 \text{ mm}, \bar{y} = 86.6 \text{ mm}, \phi = 19.1^\circ$
9-55 $\bar{x} = 2.43 \text{ m}, \bar{y} = 1.31 \text{ m}$
9-57 $\bar{x} = 121 \text{ mm}, \bar{y} = 44.1 \text{ mm}, \bar{z} = 124 \text{ mm}$
9-58 $\bar{x} = 1.60 \text{ ft}, \bar{y} = 7.04 \text{ ft}, A_x = 0, A_y = 149 \text{ lb},$
 $M_A = 502 \text{ lb} \cdot \text{ft}$
9-59 $\bar{y} = \frac{h}{3}\left(\frac{2b_1 + b_2}{b_1 + b_2}\right)$
9-61 $\bar{x} = 2.64 \text{ in.}, \bar{y} = 12 \text{ in.}$
9-62 $\bar{x} = 4.83 \text{ in.}, \bar{y} = 2.56 \text{ in.}$
9-63 $\bar{y} = 11.9 \text{ in.}$
9-65 $\bar{x} = 0, \bar{y} \approx 545 \text{ mm}$
9-66 $\bar{y} = 272 \text{ mm}$
9-67 $\bar{y} = 324 \text{ mm}$
9-69 $\bar{x} = 105 \text{ mm}$
9-70 $\bar{y} = 5.12 \text{ in.}$
9-71 $\bar{x} = 2.11 \text{ ft}, \bar{y} = 1.34 \text{ ft}$
9-73 $\bar{x} = 2.5 \text{ in.}, \bar{y} = 4 \text{ in.}$
9-74 $\bar{x} = 7.18 \text{ ft}, A_y = 667 \text{ lb}, B_y = 2.63 \text{ kip}$
9-75 $\bar{y} = 58.1 \text{ mm}$
9-77 $\theta = 53.1^\circ$
9-78 $\bar{y} = 154 \text{ mm}$
9-79 $\bar{x} = 2.19 \text{ in.}, \bar{y} = 2.79 \text{ in.}, \bar{z} = 1.67 \text{ in.}$
9-81 $\bar{x} = \frac{L + (n - 1)d}{2}$
9-82 N/A
9-83 $d = 3 \text{ m}$
9-85 $\bar{x} = 13.1 \text{ mm}, \bar{z} = 22.5 \text{ mm}, \theta_{\max} = 30.1^\circ$
9-86 $\bar{z} = 111 \text{ mm}$
9-87 $\bar{x} = 4.56 \text{ m}, \bar{y} = 3.07 \text{ m}, B_y = 4.66 \text{ kN},$
 $A_y = 5.99 \text{ kN}$
9-89 $\bar{y} = 2.57 \text{ in.}$
9-90 $V = 101 \text{ ft}^3$
9-91 $A = 141 \text{ in}^2$
9-93 $W = 3.01 \text{ lb}$
9-94 $A = 70.0 \text{ in}^2$
9-95 $R = 29.3 \text{ kip}$
9-97 $A = 302 \text{ m}^2$
9-98 $V = 536 \text{ m}^3$
9-99 $A = 88.0 \text{ m}^2$
9-101 $A = 141 \text{ in}^2$
9-102 $V = 49.1 \text{ in}^3$
9-103 $V = 25.5 \text{ m}^3$
9-105 $V = 0.0486 \text{ m}^3$
9-106 $V = 3.49 \text{ m}^3$
9-107 $A = 1.36(10^3)$
9-109 $h = 29.9 \text{ mm}$
9-110 $V = 207 \text{ m}^3, A = 188 \text{ m}^2$
9-111 $W = 3.12(10^6) \text{ lb}$
9-113 $V = 1.40(10^3) \text{ in}^3$
9-114 $A = 119(10^3) \text{ mm}^2$
9-115 $F_R = 7.62 \text{ kN}, \bar{x} = 2.74 \text{ m}, \bar{y} = 3 \text{ m}$
9-117 $F_R = 678 \text{ lb}, \bar{x} = 0.948 \text{ ft}, \bar{y} = 1.50 \text{ ft}$
9-118 $F_R = 4.00 \text{ kip}, \bar{y} = -6.49 \text{ ft}$

- 9-119** $F_{Rx} = 628 \text{ kN}$, $F_{Ry} = 538 \text{ kN}$
9-121 $F_{RA} = 157 \text{ kN}$, $F_{RB} = 235 \text{ kN}$, $d_o = 4.22 \text{ m}$
9-122 $F_{CDEF} = 750 \text{ lb}$, $F_{ABDC} = 1.8 \text{ kip}$
9-123 $F_R = 83.4 \text{ kN}$
9-125 $F_R = 117 \text{ lb}$, $d = 13.1 \text{ in.}$
9-126 $d_{\min} = 2.69 \text{ m}$
9-127 $F_{R1} = 13.8 \text{ kip}$ on $ABDC$,
 $F_{R2} = 61.4 \text{ kip}$ on $BDFE$
9-129 $h = 6.67 \text{ m}$
9-130 $h = 7.73 \text{ m}$

Chapter 10

- 10-1** $I_x = 2.13 \text{ m}^4$
10-2 $I_y = 4.57 \text{ m}^4$
10-3 $I_x = 0.533 \text{ m}^4$
10-5 $I_x = \frac{2}{7}bh^3$
10-6 $I_y = \frac{2}{15}hb^3$
10-7 $I_x = \frac{\pi r_0^4}{8}$
10-9 $I_x = 10.7 \text{ in}^4$
10-10 $I_x = 3.20 \text{ m}^4$
10-11 $I_x = 1.54 \text{ in}^4$
10-13 $I_x = 0.0606 \text{ m}^4$
10-14 $I_y = 0.222 \text{ m}^4$
10-15 $I_x = 19.5 \text{ in}^4$
10-17 $I_x = \frac{\pi r^4}{16}$
10-18 $I_y = \frac{b^3h}{6}$
10-19 $I_x = 39.0 \text{ m}^4$
10-21 $I_x = 0.533 \text{ m}^4$
10-22 $I_y = 2.44 \text{ m}^4$
10-23 $I_x = \frac{3ab^3}{35}$
10-25 $\bar{y} = 1.83 \text{ in.}$, $I_{x'} = 33.5 \text{ in}^4$
10-26 $I_y = 74 \text{ in}^4$
10-27 $\bar{y} = 2 \text{ in.}$, $I_{x'} = 128 \text{ in}^4$
10-29 $I_x = \frac{1}{12}a^4$
10-30 $I_x = 548(10^6) \text{ mm}^4$
10-31 $I_y = 548(10^6) \text{ mm}^4$
10-33 $I_y = 388 \text{ in}^4$
10-34 $I_x = 115(10^6) \text{ mm}^4$
10-35 $I_y = 153(10^6) \text{ mm}^4$
10-37 $I_y = 10.3(10^9) \text{ mm}^4$
10-38 $I_y = 914(10^6) \text{ mm}^4$
10-39 $\bar{y} = 334 \text{ mm}$, $I_{x'} = 3.83(10^9) \text{ mm}^4$
10-41 $I_y = 29.8(10^6) \text{ mm}^4$
10-42 $I_x = 154(10^6) \text{ mm}^4$
10-43 $I_y = 91.3(10^6) \text{ mm}^4$
10-45 $\bar{x} = 61.6 \text{ mm}$, $I_{y'} = 41.2(10^6) \text{ mm}^4$
10-46 $I_x = 52.7(10^6) \text{ mm}^4$
10-47 $I_y = 2.51(10^6) \text{ mm}^4$
10-49 $J_O = \frac{1}{32}\pi d^4 - \frac{1}{6}a^4$
10-50 $\bar{y} = 0.181 \text{ m}$, $I_{x'} = 4.23(10^{-3}) \text{ m}^4$
10-51 $I_{x'} = 520(10^6) \text{ mm}^4$
10-53 $I_y = 45.5(10^6) \text{ mm}^4$
10-54 $I_{xy} = \frac{1}{6}l^3t \sin 2\theta$
10-55 $I_{xy} = 48 \text{ in}^4$
10-57 $I_{xy} = \frac{3}{16}b^2h^2$
10-58 $I_{xy} = \frac{3}{16}b^2h^2$
10-59 $I_{xy} = 10.7 \text{ in}^4$
10-61 $I_{xy} = 0.667 \text{ in}^4$
10-62 $I_{xy} = -28.1(10^3) \text{ mm}^4$
10-63 $I_u = 15.8 \text{ in}^4$, $I_v = 25.8 \text{ in}^4$
10-65 $I_{xy} = \frac{a^2c \sin^2 \theta}{12} (4a \cos \theta + 3c)$
10-66 $I_{xy} = 98.4(10^6) \text{ mm}^4$
10-67 $I_{xy} = -110 \text{ in}^4$
10-69 $\bar{y} = 4.67 \text{ in.}$, $I_x = 1.47(10^3) \text{ in}^4$, $I_y = 2.50(10^3) \text{ in}^4$
10-70 $\bar{x} = 1.68 \text{ in.}$, $\bar{y} = 1.68 \text{ in.}$, $I_{\max} = 31.7 \text{ in}^4$,
 $I_{\min} = 8.07 \text{ in}^4$, $\theta_{p1} = 45^\circ$, $\theta_{p2} = -45^\circ$
10-71 $\bar{x} = 1.68 \text{ in.}$, $\bar{y} = 1.68 \text{ in.}$, $I_{\max} = 31.7 \text{ in}^4$,
 $I_{\min} = 8.07 \text{ in}^4$, $\theta_{p1} = 45^\circ$, $\theta_{p2} = -45^\circ$
10-73 $\bar{x} = 48.2 \text{ mm}$, $I_u = 112(10^6) \text{ mm}^4$,
 $I_v = 258(10^6) \text{ mm}^4$, $I_{uv} = -126(10^6) \text{ mm}^4$
10-74 $I_{\max} = 117(10^6) \text{ mm}^4$, $I_{\min} = 28.8(10^6) \text{ mm}^4$
10-75 $I_{\max} = 117(10^6) \text{ mm}^4$, $I_{\min} = 28.8(10^6) \text{ mm}^4$
10-77 $I_u = 43.9 \text{ in}^4$, $I_v = 23.6 \text{ in}^4$, $I_{uv} = 17.5 \text{ in}^4$
10-78 $I_u = 909(10^6) \text{ mm}^4$, $I_v = 703(10^6) \text{ mm}^4$,
 $I_{uv} = 179(10^6) \text{ mm}^4$
10-79 $I_u = 909(10^6) \text{ mm}^4$, $I_v = 703(10^6) \text{ mm}^4$,
 $I_{uv} = 179(10^6) \text{ mm}^4$
10-81 $\theta_{p1} = -27.3^\circ$, $I_{\max} = 24.6(10^6) \text{ mm}^4$,
 $I_{\min} = 2.56(10^6) \text{ mm}^4$
10-82 $\theta_{p1} = -22.5^\circ$, $I_{\max} = 250 \text{ in}^4$, $I_{\min} = 20.4 \text{ in}^4$
10-83 $\theta_{p1} = -22.5^\circ$, $I_{\max} = 250 \text{ in}^4$, $I_{\min} = 20.4 \text{ in}^4$
10-85 $I_x = \frac{2}{5}mb^2$
10-86 $k_x = 1.20 \text{ in.}$
10-87 $k_y = 1.56 \text{ in.}$
10-89 $k_x = 57.7 \text{ mm}$

- 10-90** $I_x = \frac{3}{10}mr^2$
10-91 $I_y = 2.25 \text{ slug} \cdot \text{ft}^2$
10-93 $I_y = \frac{5}{18}m$
10-94 $I_z = \frac{7}{18}ma^2$
10-95 $I_O = 0.450 \text{ g} \cdot \text{m}^2$, $\bar{y} = 57.7 \text{ mm}$, $I_G = 0.150 \text{ g} \cdot \text{m}^2$
10-97 $I_z = 1.53 \text{ kg} \cdot \text{m}^2$
10-98 $I_A = 2.17 \text{ slug} \cdot \text{ft}^2$
10-99 $I_O = 5.27 \text{ kg} \cdot \text{m}^2$
10-101 $I_O = 0.276 \text{ kg} \cdot \text{m}^2$
10-102 $\bar{y} = 203 \text{ mm}$, $I_G = 0.230 \text{ kg} \cdot \text{m}^2$
10-103 $I_O = \frac{1}{2}ma^2$
10-105 $I_z = 0.113 \text{ kg} \cdot \text{m}^2$
10-106 $I_G = 118 \text{ slug} \cdot \text{ft}^2$
10-107 $I_O = 293 \text{ slug} \cdot \text{ft}^2$
10-109 $I_z = 34.2 \text{ kg} \cdot \text{m}^2$

Chapter 11

- 11-1** $F_{AD} = 3.92 \text{ kN (C)}$
11-2 $P = 2W \cot \theta$
11-3 $F_s = 10.0 \text{ lb}$
11-5 $\theta = 27.4^\circ$, or 72.7°
11-6 $k = 1.05 \text{ kN/m}$
11-7 $F_E = 177 \text{ N}$
11-9 $k = 10.8 \text{ lb/ft}$
11-10 $\theta = \cos^{-1} \left(\frac{a}{2L} \right)^{\frac{1}{3}}$
11-11 $P = \frac{ka(a \sin \theta - l_0)}{l}$
11-13 $F = 13.9 \text{ N}$
11-14 $M = 43.3 \text{ N} \cdot \text{m}$
11-15 $\theta = 24.9^\circ$
11-17 $F_C = 427 \text{ N}$
11-18 $P = 2k \tan \theta (2l \cos \theta - l_0)$
11-19 $P = 2k(2l \cos \theta - l_0)$
11-21 $\theta = 90^\circ$, or 33.4°
11-22 $F = 259 \text{ lb}$
11-23 $W_G = 2.5 \text{ lb}$
11-25 $\theta = \sin^{-1} \left(\frac{4W}{ka} \right)$, or 90°
11-26 Unstable at $x = -0.5 \text{ ft}$, Stable at $x = 0.833 \text{ ft}$
11-27 Unstable at $\theta = 38.7^\circ$, Stable at $\theta = 90^\circ$,
Unstable at $\theta = 141^\circ$
11-29 Unstable at $x = -0.424 \text{ ft}$, Stable at $x = 0.590 \text{ ft}$
11-30 Unstable at $\theta = 34.6^\circ$, Stable at $\theta = 145^\circ$
11-31 Unstable at $\theta = 17.5^\circ$, Stable at $\theta = 70.9^\circ$
11-33 $W_D = 275 \text{ lb}$
11-34 $\theta = \sin^{-1} \left(\frac{W}{2kL} \right)$
11-35 Stable at $h = 8.71 \text{ in.}$
11-37 Unstable at $\theta = 0^\circ$, Stable at $\theta = 71.5^\circ$
11-38 N/A
11-39 $W = \frac{8k}{3L}$
11-41 Unstable at $\theta = 23.9^\circ$
11-42 $b < 2r$
11-43 Unstable at $\theta = 12.1^\circ$
11-45 Stable at $\theta = 76.8^\circ$
11-46 Unstable at $\theta = 0^\circ$
11-47 $h = 1.35 \text{ in.}$
11-49 $h = 0$