3.10-19. (a) $u_A = -2.05(10^{-3})$ in., $v_A = -4.90(10^{-2})$ in., (b) $F_1 = 9.78$ kips, $F_2 = 10.11$ kips, $F_3 = 0.853$ kips
3.10-21. (a) $u_A = 3.20(10^{-2})$ in., $v_A = 2.84(10^{-3})$ in., (b) $\sigma_1 = 6.07$ ksi (T), $\sigma_2 = 5.36$ ksi (C), $\sigma_3 = 7.51$ ksi (T)
3.10-23. (a) $P = 57.3$ kN, (b) $F_1 = 22.4$ kN, $F_2 = 35.0$ kN, $F_3 = 8.75$ kN, (c) $R_y = -5.86$ kN
3.10-25. (a) $u_A = -1.222$ mm, (b) $\sigma_1 = 13.68$ MPa (C), $\sigma_2 = 13.62$ MPa (T), $\sigma_3 = 5.35$ MPa (C)

3.11-1. (a) $P_{Y1} = 15$ kips, (b) $u_C = 0.1333$ in.
3.11-3. (a) $P_Y = 43.2$ kips, $u_Y = 0.0240$ in., (a) $P_U = 57.6$ kips, $u_U = 0.0480$ in.
3.11-5. (a) $P_Y = 145.7$ kips, $u_Y = 0.0576$ in., (a) $P_U = 187.2$ kips, $u_U = 0.0900$ in.
3.11-7. $(\sigma_1)_{\text{resid}} = (\sigma_2)_{\text{resid}} = 5.67$ ksi (C)

CHAPTER 4

4.2-1. (a) $(\gamma_s)_{\max} = 240\,(10^{-6})$ rad (b) $\phi(L) - \phi(0) = 0.01152$ rad

4.3-1. $T = 665$ N·m, (b) $\phi = 0.1067$ rad
4.3-3. (a) $\tau_{\max} = 9.55$ ksi, (b) $T_c\% = 6.25\%$, (c) $W_c\% = 25\%$
4.3-5. $d_{\text{req'd}} = 109$ mm $\quad (> d_T = 108.4$ mm)
4.3-7. (a) $T_T = \dfrac{\pi \tau_{\text{allow}} d^3}{16}$, (b) $T_\phi = \dfrac{\pi G d^4 \left(\frac{d\phi}{dx}\right)_{\text{allow}}}{32}$
4.3-9. (a) $\%W_{\text{red}} = 77.6\%$, (b) $\%W_{\text{red}} = 87.3\%$
4.3-11. $\tau_{\max}(x) = \dfrac{16T_0}{\pi d_0^3}\left(1 + \dfrac{x}{L}\right)^{-3}$, (b) $\phi_0 = \dfrac{28T_0L_0}{3\pi G d_0^4}$
4.3-13. (a) $\tau_{\max}(x) = \dfrac{32t_0L}{\pi^2 d^3}\left[1 - \sin\left(\dfrac{\pi x}{2L}\right)\right]$,
(b) $\phi_B = \dfrac{64t_0L^2}{\pi^2 G d^4}\left(1 - \dfrac{2}{\pi}\right)$
4.3-15. (a) $\tau_{\max} = 1.293$ MPa (acts at the outer surface of member (2), (b) $\phi_{C/A} = 1.078\,(10^{-3})$ rad
4.3-17. $T_A = -\dfrac{4t_0L}{\pi^2}$, $T_B = \left(\dfrac{4 - 2\pi}{\pi^2}\right) t_0 L$

4.4-1. (a) The cast-iron bar failed in tension.
(b)The chalk is brittle and fails in tension like cast iron (i.e., Fig. 4.17*b*).
4.4-3. $T_{\max} = 314$ lb·in., (b) The dowel fails in shear parallel to the grain of the wood.
4.4-5. (a) $(\sigma_{\max})_T = 37.7$ MPa, $(\sigma_{\max})_C = -37.7$ MPa, $\tau_{\max} = 37.7$ MPa, (b) —
4.4-7. (a) $(\sigma_{\max})_T = 4.62$ ksi, $(\sigma_{\max})_C = -4.62$ ksi, $\tau_{\max} = 4.62$ ksi, (b) —
4.4-9. (a) $T = 125.7$ N · m, (b) $(\sigma_{\max})_T = 80.0$ MPa
4.4-11. (a) $T = 90.8$ kip · in., (b) $(\sigma_{\max})_T = 33.1$ ksi
4.4-13. (a) $\gamma_{\max} = 1.479\,(10^{-3})$ rad, (b) $(\epsilon_{\max})_T = 0.739\,(10^{-3})$ m/m

4.5-1. (a) $\tau_{\max} = (\tau_{\max})_1 = 2.47$ ksi, (b) $\phi_C = 1.311\,(10^{-3})$ rad
4.5-3. (a) $\tau_{\max} = 31.8$ MPa, (b) $\phi_C = 38.8\,(10^{-3})$ rad
4.5-5. (a) $(\tau_{\max})_1 = 4.07$ ksi, $(\tau_{\max})_2 = 6.11$ ksi, (b) $\phi_{C/A} = -6.79\,(10^{-4})$ rad
4.5-7. (a) $\tau_{\max} = (\tau_{\max})_3 = 163.0$ MPa, (b) $\phi_{D/A} = 0.0678$ rad
4.5-9. $\phi_{D/A} = 0.01372$ rad
4.5-11. (a) $\tau_{\max} = (\tau_{\max})_1 = 4.51$ ksi, (b) $\phi_A = -0.01661$ rad, (c) $k_t = 72.3\ \dfrac{\text{kip} \cdot \text{in.}}{\text{rad}}$
4.5-13. $k_t = 13.18\ \dfrac{\text{kN} \cdot \text{m}}{\text{rad}}$
4.5-15. $(d_{i2})_{\max} = 38$ mm

4.6-1. (a) $T_1 = -1133$ lb·in. $T_2 = 2867$ lb·in., (b) $(\tau_{\max})_1 = 5769$ psi, $(\tau_{\max})_2 = 4327$ psi, (c) $\phi_B = 7.69\,(10^{-3})$ rad
4.6-3. $L_2/L_1 = d_2/d_1$
4.6-5. (a) $T_1 = -4.40$ kN·m, $T_2 = 5.60$ kN·m, (b) $(\tau_{\max})_1 = 66.2$ MPa, $(\tau_{\max})_2 = 84.3$ MPa, (c) $\sigma_{\max T} = 84.3$ MPa
4.6-7. (a) $(\tau_{\max})_1 = 11.68$ ksi, $(\tau_{\max})_2 = 6.92$ ksi, (b) $\phi_A = 0.1245$ rad
4.6-9. $t = 3.41$ mm
4.6-11. (a) $T_1 = 470$ lb·in., $T_2 = 2030$ lb·in., (b) $(\tau_{\max})_1 = 2390$ psi, $(\tau_{\max})_2 = 4190$ psi, (c) $\phi_B = 0.00871$ rad, (d) $k_t = 287\ \dfrac{\text{kip} \cdot \text{in.}}{\text{rad}}$
4.6-13. (a) $(\tau_{\max})_1 = 6.27$ ksi, $(\tau_{\max})_2 = 3.92$ ksi, (b) $(\tau_{\max})_1 = 8.58$ ksi, $(\tau_{\max})_2 = 1.610$ ksi
4.6-15. (a) $(\tau_{\max})_1 = \dfrac{12T_0}{\pi d^3}$, $(\tau_{\max})_2 = \dfrac{20T_0}{\pi d^3}$, $(\tau_{\max})_3 = \dfrac{4T_0}{\pi d^3}$, (b) $\phi_B = -\dfrac{12T_0L}{\pi G d^4}$
4.6-17. (a) $(T_B)_i = 696$ N·m, (b) $(T_B)_f = 5.11$ kN·m

4.7-1. (a) $\phi_B = 3.77(10^{-3})$ rad, (b) $T_1 = -444$ lb·in., $T_2 = 3560$ lb·in., (c) $(\tau_{\max})_1 = (\tau_{\max})_2 = 2.26$ ksi
4.7-3. (a) $\phi_B = \dfrac{32L_1L_2T_B}{\pi d^4(G_1L_2 + G_2L_1)}$,
(b) $T_1 = \dfrac{-G_1L_2T_B}{G_1L_2 + G_2L_1}$, $T_2 = \dfrac{G_2L_1T_B}{G_1L_2 + G_2L_1}$
(c) $(\tau_{\max})_1 = \dfrac{16G_1L_2T_B}{\pi d^3(G_1L_2 + G_2L_1)}$, $(\tau_{\max})_2 = \dfrac{16G_2L_1T_B}{\pi d^3(G_1L_2 + G_2L_1)}$
4.7-5. $t = 3.41$ mm
4.7-7. (a) $\overline{\phi}_C = 1.493°$, (b) $(\tau_{\max})_1 = 5.27$ ksi, $(\tau_{\max})_2 = 6.05$ ksi
4.7-9. (a) $\phi_C = -1.048(10^{-2})$ rad, $\phi_B = 5.99(10^{-3})$ rad, (b) $T_1 = 302$ N·m, $T_2 = -172.6$ N·m, (c) $\tau_{\max} = (\tau_{\max})_1 = 46.9$ MPa
4.7-11. (a) $\phi_B = 3.22(10^{-3})$ rad, $\phi_C = -2.85(10^{-3})$ rad, (b) $\tau_{\max} = (\tau_{\max})_2 = 1.443$ ksi