Solutions

2.1

- Gain $= K/(bR + K^2) = 0.08/(4 \times 10^{-5} + 0.0064) =$ **12.42** rad/s per V.
- $\omega = V(\Omega/V) = 24 \times 12.42 =$ **298** rad/s (2850 rpm).

2.2

- $\tau_m = JR/(bR + K^2) = 10^{-4}/0.00644 =$ **15.5** ms.
- $\tau_e = L/R = 3 \times 10^{-3}/2 =$ **1.5** ms.
- Stall: $i = V/R = 12$ A, $T = Ki =$ **0.96** N $\cdot$ m.

3.1

- (a) $T_m = T_L/(N\eta) = 8/(30 \times 0.85) =$ **0.314** N $\cdot$ m.
- $i = T_m/K =$ **3.92** A; at rest no back emf, so $V = iR =$ **7.84** V.
- (b) No load: $298/30 =$ **9.94** rad/s.
- Under load only $24 - 7.84 = 16.16$ V drives speed: $16.16 \times 12.42/30 =$ **6.69** rad/s.
- $90° = 1.571$ rad: $t \geq 1.571/6.69 =$ **0.235** s.
- (c) $T_{valve} = KiN\eta = 0.08 \times 6 \times 30 \times 0.85 =$ **12.2** N $\cdot$ m, 1.5 times the load.
- $P = T_m\omega_m = 0.314 \times (6.69 \times 30) =$ **63** W.

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