

1. 1.875 min or "less than 2 min"

2. 7.5 min

$$3. \rho = 2.3 \text{ g/cm}^3 (1 \text{ kg}/1000 \text{ g})(100 \text{ cm}/\text{m})^3 = 2300 \text{ kg/m}^3$$

$$m = \rho V = (500 \times 10^{-6})(1 \times 10^{-3})^2 (2300) = 1.15 \times 10^{-6} \text{ kg}$$

$$K = \frac{N_{\text{leg}}}{N_{\text{zig}}} \frac{E w t^3}{L^3} = \frac{2}{1} \frac{(190 \times 10^9)(10 \times 10^{-6})(5 \times 10^{-6})^3}{(100 \times 10^{-6})^3} = 475 \text{ N/m}$$

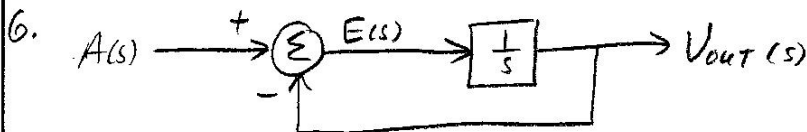
$$\omega^2 = \frac{K}{m} = \frac{475}{1.15 \times 10^{-6}} = 4.13 \times 10^8 \text{ (rad/s)}^2$$

$$s = \frac{1}{\omega^2} = 2.42 \times 10^{-9} \text{ s}^2$$

$$4. d = a s = \frac{a}{\omega_n^2} = \frac{10(9.8)}{(2\pi \times 1000)^2} = 2.48 \times 10^{-6} \text{ m} = 2.48 \mu\text{m}$$

$$5. s = \frac{d}{a} = \frac{10 \times 10^{-6}}{10(9.8)} = 1.02 \times 10^{-7} \text{ s}^2$$

$$s = \frac{1}{\omega_n^2} \rightarrow f_n = \frac{\omega_n}{2\pi} = \frac{1}{2\pi \sqrt{s}} = \frac{1}{2\pi \sqrt{1.02 \times 10^{-7}}} = 498 \text{ Hz}$$



$$(1) E(s) = A(s) - V_{\text{out}}(s)$$

$$(2) V_{\text{out}}(s) = \frac{E(s)}{s}$$

$$\therefore V_{\text{out}}(s) = \frac{A(s) - V_{\text{out}}(s)}{s}$$

$$\text{or } s V_{\text{out}}(s) = A(s) - V_{\text{out}}(s)$$

$$\therefore V_{\text{out}}(s) [s+1] = A(s)$$

$$\therefore G(s) = \frac{V_{\text{out}}(s)}{A(s)} = \frac{1}{s+1}$$

$$A(s) = \mathcal{L}[2u(t)] = \frac{2}{s}$$

$$V_{out}(s) = A(s)G(s) = \frac{2}{s(s+1)} = \frac{K_1}{s} + \frac{K_2}{s+1}$$

$$K_1 = \left. \frac{2}{s+1} \right|_{s=0} = 2$$

$$K_2 = \left. \frac{2}{s} \right|_{s=-1} = -2$$

$$\therefore V_{out}(s) = \frac{2}{s} - \frac{2}{s+1}$$

$$v_{out}(t) = \mathcal{L}^{-1}[V_{out}(s)] = 2(1 - e^{-t})$$

3-0235 — 50 SHEETS — 5 SQUARES  
 3-0236 — 100 SHEETS — 5 SQUARES  
 3-0237 — 200 SHEETS — 5 SQUARES  
 3-0137 — 200 SHEETS — FILLER

COMET