HW Assignment Solution for EML 4806 CH 9

Problem 3:

$$\boxed{x(t) = 4(1+t)e^{-t}}$$

Problem 12:

Shaft appears stiffer due to gears:

$$K = 500 \times 8^2 = 32000; \quad W_{\text{RES}} = \sqrt{32000/\text{I}}$$

$$= 178.88 \text{ rad/sec} \cong \boxed{28.47 \text{ Hz}}$$

Problem 22:

Closed loop system is:

$$m\ddot{x} + b'\dot{x} + k'x = 0 \quad (9.38)$$

where $b' = b + k_v$ and $k' = k + k_p$. Critical damping requires that $b' = 2\sqrt{mk'}$.

Using rule (9.72), if $\omega_{\text{res}} = 6$ rad/sec then we should design the servo to have $\omega_n = 3$ rad/sec. From (9.20) $\omega_n = \sqrt{k/m}$ (in our case k') so,

$$3 = \sqrt{k'/m}; \quad k' = 18$$
$$k_p = k' - k = 18 - 8 = 10$$
$$b' = 2\sqrt{mk'} = 2\sqrt{36} = 12; \quad k_v = b' - b = 12 - 3 = 9$$