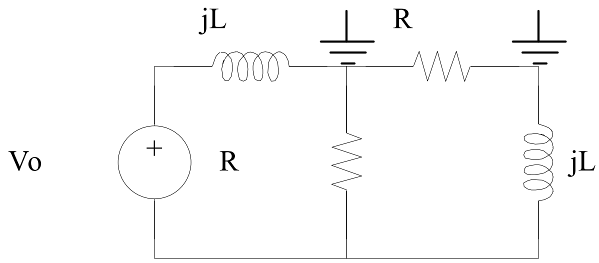
Chapter 10, Solution 96.

(a) Consider the feedback portion of the circuit, as shown below.



$$V_2 = \frac{j\omega L}{R + j\omega L} V_1 \rightarrow V_1 = \frac{R + j\omega L}{j\omega L} V_2 \qquad (1)$$

Applying KCL at node 1,

$$\frac{V_o - V_1}{j\omega L} = \frac{V_1}{R} + \frac{V_1}{R + j\omega L}$$

$$V_o - V_1 = j\omega L\, V_1 \left(\frac{1}{R} + \frac{1}{R + j\omega L} \right)$$

$$V_o = V_1 \left(1 + \frac{j2\omega RL - \omega^2 L^2}{R\,(R + j\omega L)} \right)$$

(2)

From (1) and (2),

$$V_o = \left(\frac{R + j\omega L}{j\omega L} \right) \left(1 + \frac{j2\omega RL - \omega^2 L^2}{R\,(R + j\omega L)} \right) V_2$$

$$\frac{V_o}{V_2} = \frac{R^2 + j\omega RL + j2\omega RL - \omega^2 L^2}{j\omega RL}$$

$$\frac{V_2}{V_o} = \frac{1}{3 + \dfrac{R^2 - \omega^2 L^2}{j\omega RL}}$$

$$\frac{V_2}{V_o} = \frac{1}{3 + j\,(\omega L / R - R / \omega L)}$$

(b) Since the ratio $\frac{V_2}{V_o}$ must be real,

$$\frac{\omega_o L}{R} - \frac{R}{\omega_o L} = 0$$

$$\omega_o L = \frac{R^2}{\omega_o L}$$

$$\omega_o = 2\pi f_o = \frac{R}{L}$$

$$f_o = \frac{R}{2\pi L}$$

(c) When $\omega = \omega_o$

$$\frac{V_2}{V_o} = \frac{1}{3}$$

This must be compensated for by $A_v = 3$. But

$$A_v = 1 + \frac{R_2}{R_1} = 3$$

$$R_2 = 2\ R_1$$