1a. \( \omega \rightarrow 0: L \rightarrow \text{short so } \text{gain}=1. \omega \rightarrow \infty: C \rightarrow \text{short so } \text{gain}=1. \) Passes low & high freqs.

   \( 0 < \omega < \infty: L || C \) can only get larger, so \( \text{gain}<1. \) Gain has a minimum somewhere.

1b. Let \( Z = j\omega L \left| \frac{1}{j \omega C} \right| = \frac{(j\omega L)/(j\omega C)}{j\omega L + 1/(j\omega C)} = \frac{j\omega L}{1 - \omega^2 LC}. \)

   \[ H(j\omega) = \frac{V_O}{V_I} = \frac{R}{R + Z} = \frac{R(1 - \omega^2 LC)}{R(1 - \omega^2 LC) + j\omega L} = \frac{(j\omega)^2 + \frac{1}{\omega^2 RC}}{(j\omega)^2 + \frac{1}{\omega^2 RC} + \frac{1}{LC}}. \]

1c. \( |H(j\omega)| = 0 \) (can’t get smaller than that) at \( \omega_o = 1/\sqrt{LC} \) (same as series RLC).

1d. \( |H(j0)| = |H(j\infty)| = 1 \) so \( |H(j\omega)| = 1/\sqrt{2} \) at cutoff frequencies \( \omega_c1, \omega_c2. \)

   \[ |H(j\omega)| = 1/\sqrt{2} \text{ when } \pm \frac{\omega}{\sqrt{2}} = \frac{1}{\sqrt{L}} - \omega^2 \rightarrow \omega_c1, \omega_c2 = \frac{1}{2RC} + \sqrt{\frac{1}{(2RC)^2} + \frac{1}{LC}}. \]

1e. Bandwidth=\( \omega_c2 - \omega_c1 = \frac{1}{2RC}. \) As before, \( \omega_c1 \approx \omega_o - \frac{1}{2RC}; \) \( \omega_c2 \approx \omega_o + \frac{1}{2RC}. \)

1f. \( Q = \text{resonant freq}\) bandwidth = \( \omega_o RC \) (same as parallel RLC circuit).

2a. \( 2\pi(50kHz) = \frac{1}{\sqrt{LC}} \rightarrow L = 1/[(100,000\pi)^2(0.1 \times 10^{-6})] = 101.3 \mu H. \)

2a. \( Q = \omega_o RC = 100,000\pi(0.1 \times 10^{-6})R \rightarrow R = 8000 \Omega \approx 254.6 \Omega. \)

2c. \( Q = \frac{\text{resonant freq}}{\text{bandwidth}} \rightarrow \text{Bandwidth} = \frac{50kHz}{8} = 6.25 kHz. \)

2b. \( f_c1 = 50 - \frac{6.25}{2} = 46.9 kHz. \) \( f_c2 = 50 + \frac{6.25}{2} = 53.1 kHz. \)

   These differ from the exact answers using the square root by only 0.1kHz.

3a. \( \frac{V_O}{V_I} = -\frac{Z_L}{Z_I} \) where \( Z_I = R_1 + \frac{1}{j\omega C_1} = \frac{j\omega R_1 C_1 + 1}{j\omega C_1} \) and \( Z_F = R_2||\frac{1}{j\omega C_2} = \frac{R_2}{j\omega R_2 C_2 + 1}. \)

3a. \( H(j\omega) = -\frac{j\omega/(R_1 C_1)}{(j\omega + \frac{1}{j\omega C_1})(j\omega + \frac{1}{j\omega C_2})}. \) **Zero:** origin. **Poles:** \( \frac{1}{R_2 C_2}; \frac{1}{R_1 C_1}. \)

3b. \( H(j0) = 0. \) Makes sense: \( C_2 \rightarrow \text{open vanishes}; \) \( C_1 \rightarrow \text{open } \rightarrow \text{gain}=0. \)

3c. \( H(j\infty) = 0. \) Makes sense: \( C_1 \rightarrow \text{short vanishes}; \) \( C_2 \rightarrow \text{short } \rightarrow \text{gain}=0. \)

**Bode:** Zero: origin. Poles: \( \frac{1}{R_2 C_2}; \frac{1}{R_1 C_1}. \) \( \omega \rightarrow 0: |H(j\omega)| \approx \left| \frac{10^5j\omega}{10^{10} j^2} \right| = \frac{\omega}{10^5}. \)

4. \( Q = \frac{\text{resonant freq}}{\text{bandwidth}} = \frac{100kHz}{L} = 25 = \frac{(100kHz)L}{1000\Omega} \rightarrow L = 0.25 \Omega \)

100,000 = \( \frac{1}{\sqrt{LC}} \rightarrow C = 10^{-10}/0.25 = 400 \mu F. \) At resonance, impedance=\( R=1000 \Omega. \)

5a. \( V_I(t) = 12.54 - 25.08 \sum_{n=1}^{\infty} \cos(\frac{754nt}{4n^2-1}) \) where \( 2(19.7/\pi) = 12.54 \) (from inside back cover).

5b. **Pole:** \( \frac{1}{RC} = \frac{1}{2(0.00063)} = 75.4 \frac{rad}{sec} = 12Hz. \) \( \text{Gain}=\frac{1}{\sqrt{1+(\frac{f}{12})^2}} \). Phase=\( -\tan^{-1} \frac{f}{12}. \)

5c. \( V_O(t) = 12.54 - 25.08 \sum_{n=1}^{\infty} \cos\left[\frac{754nt - \tan^{-1}(10n)(n)}{(4n^2-1)\sqrt{1+100n^2}}\right] \) using \( f = 120n \rightarrow \omega RC = \frac{120n}{12} = 10n. \)