Problem 14.30 P665

14.30 A circuit consisting of a coil with inductance 10 mH and resistance 20 Ω is connected in series with a capacitor and a generator with an rms voltage of 120 V. Find:

(a) the value of the capacitance that will cause the circuit to be in resonance at 15 kHz

(b) the current through the coil at resonance

(c) the Q of the circuit

Solution:

(a) $w_0 = \dfrac{1}{\sqrt{LC}} \Rightarrow C = \dfrac{1}{w_0^2 L} = \dfrac{1}{(2\pi \times 15 \times 10^3)^2 \times 10 \times 10^{-3}} = 11.27\text{pF}$

(b) $I = \dfrac{V}{R} = \dfrac{120}{20} = 6\text{ A rms}$

(c) $Q = \dfrac{w_0 L}{R} = \dfrac{2\pi \times 15 \times 10^3 \times 10 \times 10^{-3}}{20} = 47$

(d) $P(w_0) = I^2 R = 6^2 \times 20 = 720\text{W}$

$$P(w_1) = P(w_2) = \frac{1}{2} P(w_0) = 360\text{W}$$

Problem 14.40 P665 **14.40** A parallel resonance circuit has a resistance of 2 kΩ and half-power frequencies of 86 kHz and 90 kHz. Determine:

(a) the capacitance

(b) the inductance

(c) the resonant frequency

(d) the bandwidth

(e) the quality factor

Solution:

$$w_0 = \frac{1}{2}(2\pi f_1 + 2\pi f_2) = 3.14 \times 10^3(86 + 90) = 552.6\ \text{krad/s}$$

$$B = 2\pi f_2 - 2\pi f_1 = 2 \times 3.14 \times 10^3(90 - 86) = 25.12\ \text{krad/s}$$

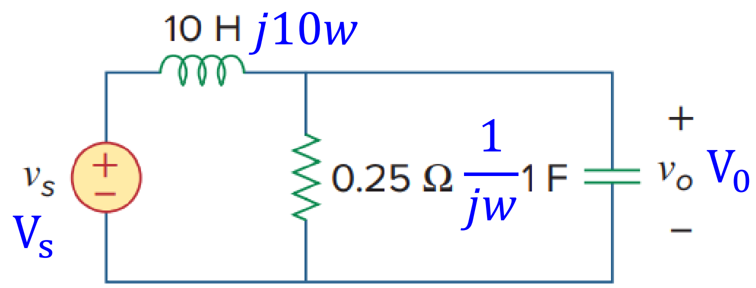
$$Q = \frac{w_0}{B} = \frac{552.6}{25.12} = 22$$

$$B = \frac{1}{RC} \Rightarrow \text{C} = \frac{1}{BR} = \frac{1}{25.12 \times 10^3 \times 2 \times 10^3} = 19.9\text{pF}$$

$$w_0 = \frac{1}{\sqrt{LC}} \Rightarrow L = \frac{1}{w_0^2 C} = \frac{1}{(552.6 \times 10^3)^2 \times 19.9 \times 10^{-9}} = 164.5\text{uH}$$

Problem 14.48 P666

14.48 Find the transfer function $\mathbf{V}_o/\mathbf{V}_s$ of the circuit in Fig. 14.86. Show that the circuit is a lowpass filter.



Solution:

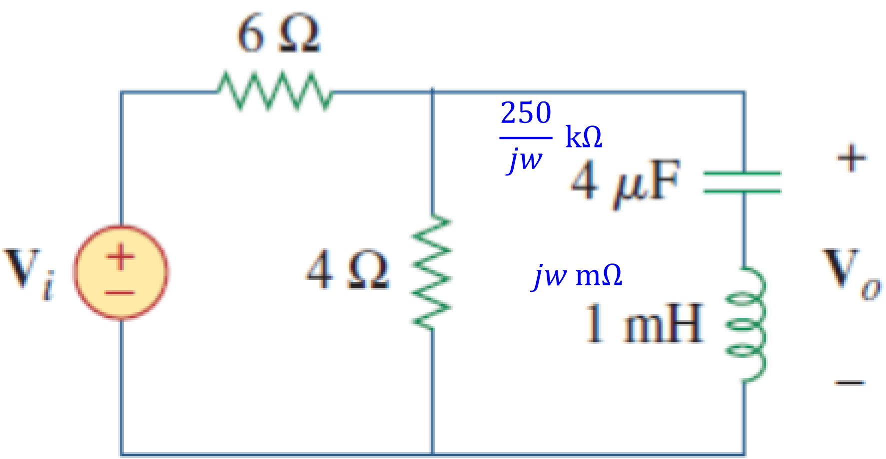
$$H(w) = \frac{V_0}{V_s} = \frac{0.25 \,\|\, \frac{1}{jw}}{j10w + 0.25 \,\|\, \frac{1}{jw}} = \frac{1}{j40w - 10w^2 + 1}$$

$$H(0) = 1, \quad H(\infty) = 0$$

So it is a lowpass filter.

Problem 14.59 P667

Find the bandwidth and center frequency of the bandstop filter of Fig. 14.89.



Solution:

$$H(w)=\frac{V_0}{V_s}=\frac{4\left\|\left(\frac{2.5\times10^5}{jw}+jw\times10^{-3}\right)\right.}{6+4\left\|\left(\frac{2.5\times10^5}{jw}+jw\times10^{-3}\right)\right.}$$

$$=\frac{10^6-4\times10^{-3}w^2}{j24w+2.5\times10^6-10^{-2}w^2}$$

$$H(0)=H(\infty)=0.4 \quad (=H_{\max})$$

$$H(w_c)=0 \Rightarrow w_c=15.8\text{krad/s}$$

$$|\mathrm{H}(w)|=\frac{1}{\sqrt{2}}H_{\max} \quad \Rightarrow \quad w_1=14.6\text{krad/s}, w_2=17\text{krad/s}$$

$$B=\ w_2-w_1=2.4\text{krad/s}$$