P 14.2 [a] $\omega_c = \dfrac{R}{L} = \dfrac{1.5 \times 10^3}{0.25} = 6000$ rad/s

$\therefore\ f_c = \dfrac{6000}{2\pi} = 954.93$ Hz

[b] $H(s) = \dfrac{R/L}{s + R/L} = \dfrac{6000}{s + 6000}$

$H(j\omega) = \dfrac{6000}{6000 + j\omega}$

$H(j\omega_c) = \dfrac{6000}{6000 + j6000} = 0.7071\underline{/-45°}$

$H(j0.3\omega_c) = \dfrac{6000}{6000 + j1800} = 0.9578\underline{/-16.70°}$

$H(j3\omega_c) = \dfrac{6000}{6000 + j18{,}000} = 0.3162\underline{/-71.57°}$

[c] $v_o(\omega_c) = 35.36\cos(6000t - 45°)$ V

$v_o(0.3\omega_c) = 47.89\cos(1800t - 16.70°)$ V

$v_o(3\omega_c) = 15.81\cos(18{,}000t - 71.57°)$ V

P 14.4 [a] $H(s) = \dfrac{V_o}{V_i} = \dfrac{R}{sL + R + R_l} = \dfrac{(R/L)}{s + (R + R_l)/L}$

[b] $H(j\omega) = \dfrac{(R/L)}{\left(\frac{R+R_l}{L}\right) + j\omega}$

$|H(j\omega)| = \dfrac{(R/L)}{\sqrt{\left(\frac{R+R_l}{L}\right)^2 + \omega^2}}$

$|H(j\omega)|_{max}$ occurs when $\omega = 0$

[c] $|H(j\omega)|_{max} = \dfrac{R}{R + R_l}$

[d] $|H(j\omega_c)| = \dfrac{R}{\sqrt{2}(R + R_l)} = \dfrac{R/L}{\sqrt{\left(\frac{R+R_l}{L}\right)^2 + \omega_c^2}}$

$\therefore\ \omega_c^2 = \left(\dfrac{R + R_l}{L}\right)^2$; $\quad\therefore\ \omega_c = (R + R_l)/L$

[e] $\omega_c = \dfrac{1575}{0.25} = 6300$ rad/s

$H(j\omega) = \dfrac{6000}{6300 + j\omega}$

$H(j0) = 0.9524$

$H(j6300) = \dfrac{0.9524}{\sqrt{2}}\underline{/-45°} = 0.6734\underline{/-45°}$

$H(j1890) = \dfrac{6000}{6300 + j1890} = 0.9122\underline{/-16.70°}$

$H(j18{,}900) = \dfrac{6000}{6300 + j18{,}900} = 0.3012\underline{/-71.57°}$

HW#10

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P 14.7 [a] $\dfrac{1}{RC} = \dfrac{10^9}{(40 \times 10^3)(2.5)} = 10\,\text{krad/s}$

$$f_c = \frac{5000}{\pi} = 1591.55\,\text{Hz}$$

[b] $H(j\omega) = \dfrac{j\omega}{10{,}000 + j\omega}$

$$H(j\omega_c) = \frac{j10{,}000}{10{,}000 + j10{,}000} = 0.7071\underline{/45^\circ}$$

$$H(j0.1\omega_c) = \frac{j1000}{10{,}000 + j1000} = 0.0995\underline{/84.29^\circ}$$

$$H(j10\omega_c) = \frac{j100{,}000}{10{,}000 + j100{,}000} = 0.9950\underline{/5.71^\circ}$$

[c] $v_o(\omega_c) = 565.69\cos(10{,}000t + 45^\circ)\,\text{mV}$

$v_o(0.1\omega_c) = 79.60\cos(1000t + 84.29^\circ)\,\text{mV}$

$v_o(10\omega_c) = 796.03\cos(100{,}000t + 5.71^\circ)\,\text{mV}$

P 14.8 [a] $H(s) = \dfrac{V_o}{V_i} = \dfrac{R}{R + R_c + (1/sC)}$

$$= \frac{R}{R + R_c} \cdot \frac{s}{|s + (1/(R + R_c)C)|}$$

[b] $H(j\omega) = \dfrac{R}{R + R_c} \cdot \dfrac{j\omega}{j\omega + (1/(R + R_c)C)}$

$$|H(j\omega)| = \frac{R}{R + R_c} \cdot \frac{\omega}{\sqrt{\omega^2 + \frac{1}{(R + R_c)^2C^2}}}$$

The magnitude will be maximum when $\omega = \infty$

[c] $|H(j\omega)|_{max} = \dfrac{R}{R + R_c}$

[d] $|H(j\omega_c)| = \dfrac{R\omega_c}{(R + R_c)\sqrt{\omega_c^2 + |1/(R + R_c)C|^2}}$

$$\therefore\ |H(j\omega)| = \frac{R}{\sqrt{2}(R + R_c)} \quad \text{when}$$

$$\therefore\ \omega_c^2 = \frac{1}{(R + R_c)^2C^2}$$

$$\text{or } \omega_c = \frac{1}{(R + R_c)C}$$

[e] $\omega_c = \dfrac{1}{(R + R_c)C} = \dfrac{10^9}{(50 \times 10^3)(2.5)} = 8000\ \text{rad/s}$

$$H(j\omega_c) = \left(\frac{40}{50}\right)\frac{j8000}{8000 + j8000} = 0.5657\underline{/45^\circ}$$

$$H(j0.1\omega_c) = \frac{(0.8)j800}{8000 + j800} = 0.0796\underline{/84.29^\circ}$$

$$H(j10\omega_c) = \frac{(0.8)j80{,}000}{8000 + j80{,}000} = 0.7960\underline{/5.71^\circ}$$

P 14.12 [a] $\omega_o^2 = \dfrac{1}{LC} = \dfrac{(10^6)(10^9)}{(40)(25)} = 10^{12}$

$$\omega_o = 10^6\ \text{rad/s} = 1\ \text{Mrad/s}$$

[b] $f_o = \dfrac{500}{\pi}\,\text{kHz} = 159.15\,\text{kHz}$

[c] $Q = \omega_o RC = (10^6)(300)(25 \times 10^{-9}) = 7.5$

[d] $\omega_{c1} = 10^6\left[-\dfrac{1}{15} + \sqrt{1 + \dfrac{1}{225}}\right] = 935.55\,\text{krad/s}$

[e] $\therefore\ f_{c1} = 148.90\,\text{kHz}$

[f] $\omega_{c2} = 10^6\left[\dfrac{1}{15} + \sqrt{1 + \dfrac{1}{225}}\right] = 1068.89\,\text{krad/s}$

[g] $\therefore\ f_{c2} = 170.12\,\text{kHz}$

[h] $\beta = \dfrac{\omega_o}{Q} = 133.33\,\text{krad/s}$ or $21.22\,\text{kHz}$

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