NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

Electric Network Analysis (EE-211)

Assignment # 4

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Question 14.14

Draw the Bode plots for

$$\mathbf{H}(\omega) = \frac{250(j\omega + 1)}{j\omega(-\omega^2 + 10j\omega + 25)}$$

Solution

$$\Rightarrow \quad \frac{250\,(j\omega+1)}{j\omega\left[(j\omega)^2 + 10 j\omega + 25\right]}$$

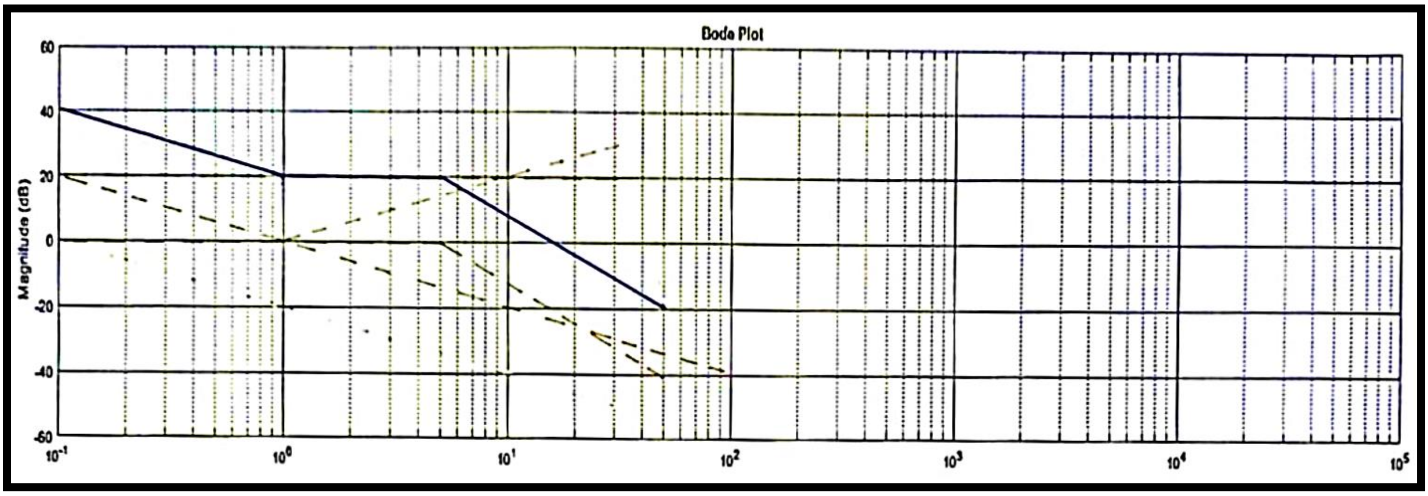
$$\Rightarrow \quad \frac{\cancel{250}\,(j\omega+1)}{j\omega\ \cancel{25}\left[(j\omega/5)^2 + \frac{10}{25}j\omega + \frac{25}{25}\right]}$$

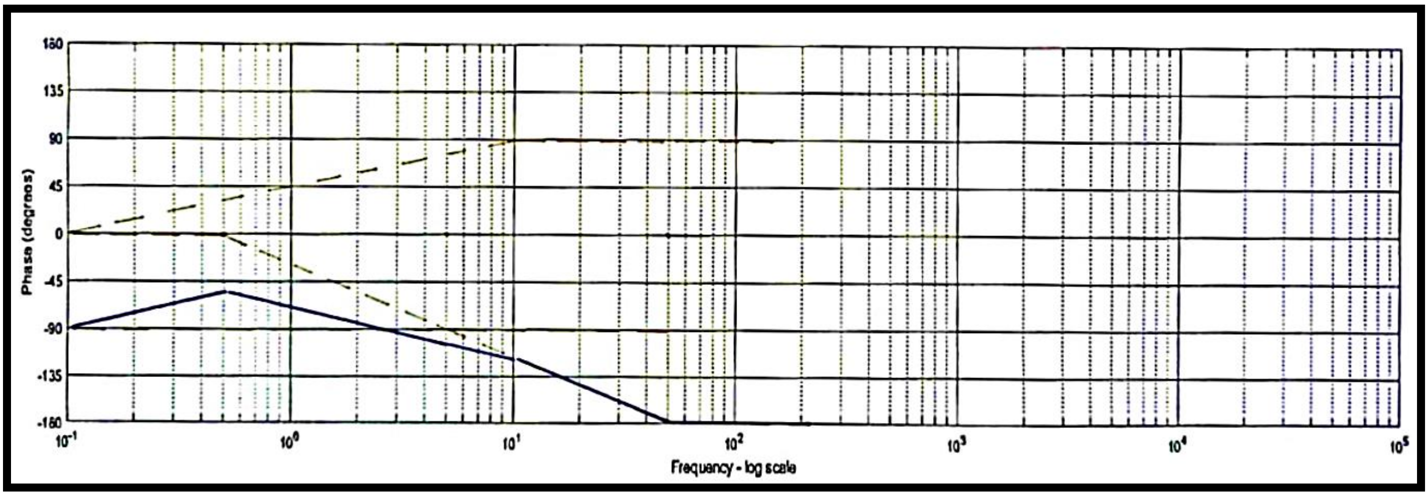
$$\Rightarrow \quad \frac{10\,(j\omega+1)}{j\omega\left[(j\omega/5)^2 + \frac{10}{25}j\omega + \frac{25}{25}\right]}$$

$$\underline{H_{dB}} = 20\log_{10}(10) + 20\log_{10}(1+j\omega) - 20\log_{10}(j\omega) - 20\log_{10}\left(1 + 2/5\,j\omega + (j\omega/5)^2\right)$$

$$\underline{\phi} = 0^\circ + \tan^{-1}(\omega) - 90^\circ - \tan^{-1}\left(\frac{2/5\,\omega}{1-\omega^2/5^2}\right)$$

Compiling and utilizing this onto a Semi-logarithmic plot:





Question 14.17

Sketch the Bode plots for

$$G(s) = \frac{s}{(s+2)^2(s+1)}, \qquad s = j\omega$$

Solution

$$\Rightarrow G(\omega) = \frac{j\omega}{(j\omega+2)^2(j\omega+1)}$$

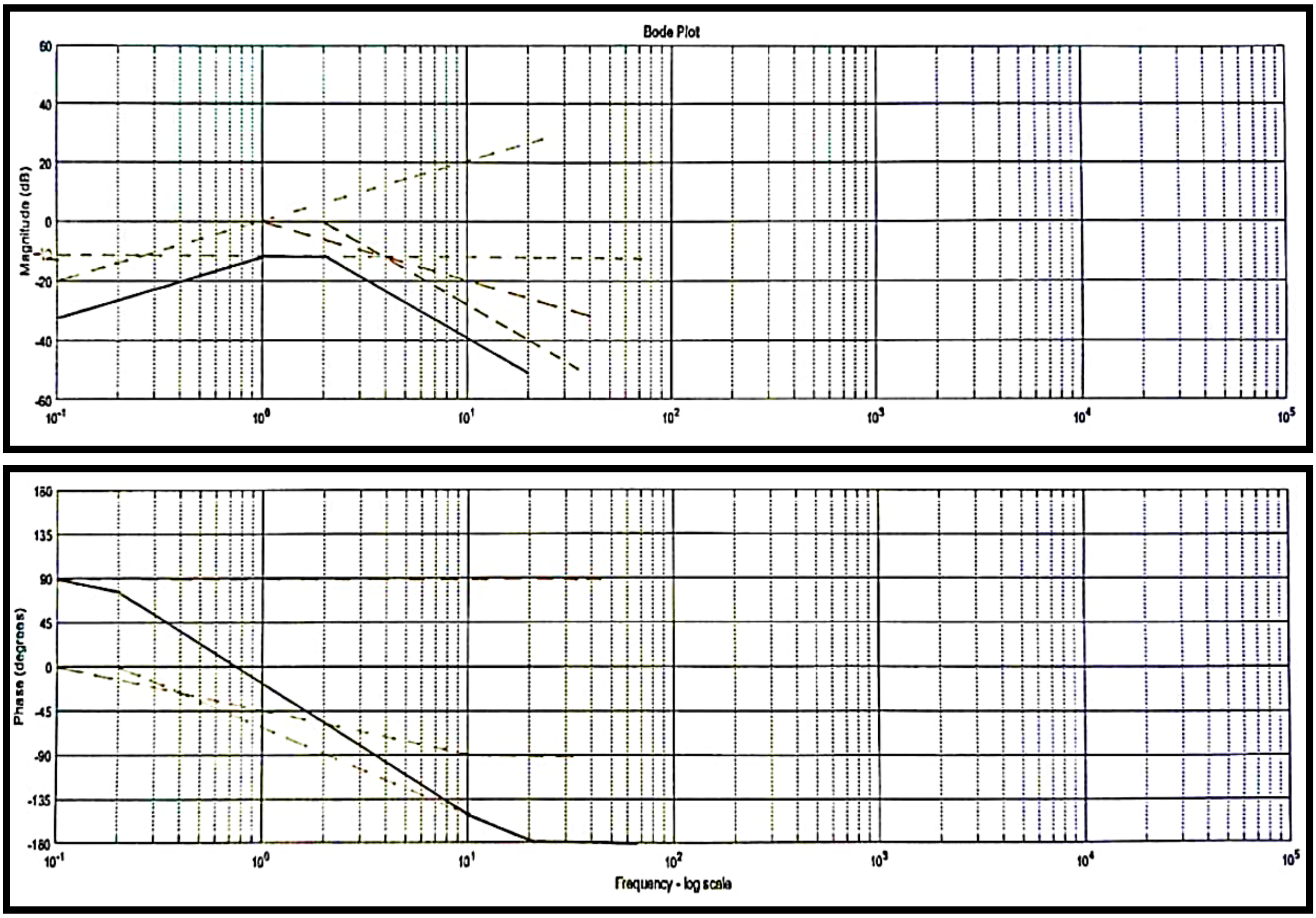
$$= \frac{j\omega}{4(1+j\omega/2)^2(1+j\omega)}$$

$$= \frac{(1/4)\, j\omega}{(1+j\omega/2)^2(1+j\omega)}$$

$$G_{dB} = -20\log_{10}(4) + 20\log_{10}(j\omega) - 40\log_{10}(1+j\omega/2) - 20\log_{10}(1+j\omega)$$

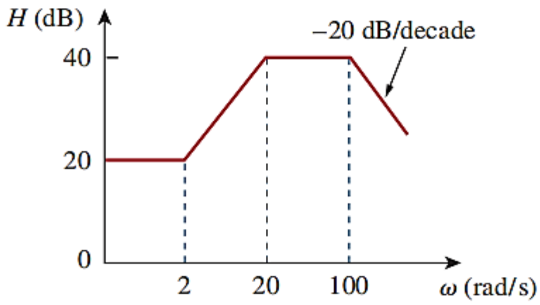
$$\phi = 0^\circ + 90^\circ - 2\tan^{-1}(\omega/2) - \tan^{-1}(\omega)$$

Compiling and utilizing this onto a semi-logarithmic plot



Question 14.22

Find the transfer function with the Bode magnitude plot shown:



Solution

$20 = 20\log_{10}(K)$

$\boxed{K = 10}$

Zero of +20 dB/sec at $2 = \omega$;

$$\boxed{1 + j\omega/2}$$

Pole of -20 dB/sec at $20 = \omega$;

$$\boxed{1/(1 + j\omega/20)}$$

Pole of -20 dB/sec at $\omega = 100$;

$$\boxed{1/(1 + j\omega/100)}$$

Thus,

$$H(\omega) = \frac{10(1 + j\omega/2)}{(1 + j\omega/20)(1 + j\omega/100)}$$

Question 14.28

Design a series *RLC* circuit with and W0=1000 rad/s. Find the circuit's *Q*. Let R=10 Ohms.

Solution

Given $R = 10\,\Omega$, $B = 20$ rad/s, $\omega_0 = 1000$ rad/s

Using,

$$B = \frac{R}{L} \Rightarrow L = \frac{R}{B} = \frac{1\cancel{0}}{2\cancel{0}} = \boxed{0.5\ H}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow \omega^2 = \frac{1}{LC}$$

$$\Rightarrow C = \frac{1}{\omega^2 L} = \frac{1}{(1000)^2 (0.5)} = \boxed{2\ \mu F}$$

$$Q = \frac{\omega_0}{B} = \frac{100\cancel{0}}{2\cancel{0}} = \boxed{50}$$

Hence, the component of RLC circuit are:

- R = 10, L = 0.5 H, C = 2μF

with Quality Factor = 50

Question 14.40

A parallel resonance circuit has a resistance of R=2k Ohms 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 factors

Solution

$$B = \omega_2 - \omega_1 = (90k - 86k)2\pi = \boxed{8\pi k \text{ rad/s}}^{d}$$

$$\omega_0 = \frac{1}{2}(\omega_2 + \omega_1) = \frac{1}{2}(176k)2\pi = \boxed{176\pi k \text{ rad/s}}^{c}$$

$$B = \frac{\omega^2 L}{R} \Rightarrow L = \frac{BR}{\omega^2} = \frac{(8\pi k)(2k)}{(176\pi k)^2} = \boxed{164.45 \mu H}^{b}$$

$$C = \frac{1}{\omega^2 L} = \frac{1}{(176\pi k)^2(164.45\mu)} = \boxed{19.89 \times 10^{-9} F}^{a}$$

$$Q = \frac{\omega_0}{B} = \frac{176\cancel{\pi}\cancel{k}}{8\cancel{\pi}\cancel{k}} = \boxed{22}^{e}$$