Solution of ECE 315 Test 12 F05

1. For the transfer function $\frac{V_o(j\omega)}{V_i(j\omega)}$, at $\omega = 30$ the magnitude Bode diagram passes through -10 dB. If $|V_o(j30)| = K|V_i(j30)|$ what is the numerical value of *K*?

K = <u>0.316</u>

$$\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right|_{\text{dB}} = 20\log_{10}\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right| \Rightarrow \left|\frac{V_o(j\omega)}{V_i(j\omega)}\right| = 10^{|V_o(j\omega)/V_i(j\omega)|_{\text{dB}}/20}$$

$$\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right|_{\text{dB}} = -10 \Rightarrow \left|\frac{V_o(j\omega)}{V_i(j\omega)}\right| = 10^{(-10/20)} = 10^{-1/2} = \frac{1}{\sqrt{10}} = 0.316 \Rightarrow K = 0.316$$

2. In an inverting op-amp amplifier, the feedback component is a 1000 Ω resistor and the component between the input voltage terminal and the operational amplifier's inverting input is a 10 μF capacitor. If the voltage transfer function is $H(f)$, what are the magnitude and phase of $H(200)$?

$|H(200)|$ = <u>12.57</u> $H(200)$ = <u>$-\pi/2 = -1.57$</u>

$$H(f) = -\frac{Z_f(f)}{Z_i(f)} = -\frac{R}{1/j2\pi fC} = -j2\pi fRC$$

$$H(200) = -j400\pi \times 1000 \times 10^{-5} = -j4\pi = -j12.57$$

$$|H(200)| = 12.57 \quad , \quad H(200) = -\pi/2 = -1.57$$

3. An active op-amp integrator has a transfer-function magnitude Bode diagram that goes through -40 dB at $\omega = 500$. At what numerical value of ω is the system transfer function magnitude 100 times smaller than it is at $\omega = 500$? ω = <u>50000</u>

A factor-of-100 reduction in system transfer function magnitude is equivalent to a change of -40 dB. Since the Bode diagram passes through -40 dB at $\omega = 500$, we need to find the frequency at which the Bode diagram passes through -80 dB. The slope of the Bodediagram for any integrator is -20 dB/decade. Therefore if the diagram passes through -40 dB at $\omega = 500$ it passes through -80 dB at $\omega = 50000$.

Solution of ECE 315 Test 12 F05

1. For the transfer function $\frac{V_o(j\omega)}{V_i(j\omega)}$, at $\omega = 30$ the magnitude Bode diagram passes through -15 dB. If $|V_o(j30)| = K|V_i(j30)|$ what is the numerical value of *K*?

K = <u>0.178</u>

$$\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right|_{\text{dB}} = 20\log_{10}\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right| \Rightarrow \left|\frac{V_o(j\omega)}{V_i(j\omega)}\right| = 10^{|V_o(j\omega)/V_i(j\omega)|_{\text{dB}}/20}$$

$$\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right|_{\text{dB}} = -15 \Rightarrow \left|\frac{V_o(j\omega)}{V_i(j\omega)}\right| = 10^{(-15/20)} = 10^{(-3/4)} = 0.178 \Rightarrow K = 0.178$$

2. In an inverting op-amp amplifier, the feedback component is a 1000 Ω resistor and the component between the input voltage terminal and the operational amplifier's inverting input is a 10 μF capacitor. If the voltage transfer function is $H(f)$, what are the magnitude and phase of $H(100)$?

$|H(100)|$ = <u>6.28</u> $\qquad$ $H(100)$ = <u>$-\pi/2 = -1.57$</u>

$$H(f) = -\frac{Z_f(f)}{Z_i(f)} = -\frac{R}{1/j2\pi fC} = -j2\pi fRC$$

$$H(200) = -j200\pi \times 1000 \times 10^{-5} = -j2\pi = -j6.28$$

$$|H(200)| = 6.28 \ , \quad H(200) = -\pi/2 = -1.57$$

3. An active differentiator has a transfer-function magnitude Bode diagram that goes through -40 dB at $\omega = 500$. At what numerical value of ω is the system transfer function magnitude 100 times smaller than it is at $\omega = 500$? $\qquad$ ω = <u>5</u>

A factor-of-100 reduction in system transfer function magnitude is equivalent to a change of -40 dB. Since the Bode diagram passes through -40 dB at $\omega = 500$, we need to find the frequency at which the Bode diagram passes through -80 dB. The

slope of the Bodediagram for any integrator is +20 dB/decade. Therefore if the diagram passes through -40 dB at $\omega = 500$ it passes through -80 dB at $\omega = 5$.