E100 MT I Soln Sp 2016

1. A transfer function magnitude at some frequency ω_1 is $|H(j\,\omega_1)| = 0.20$. What is this magnitude in dB?

$|H(j\,\omega_1)|$ = ______________________ dB

in dB: $20\log_{10}|\tilde{H}| = 20\log 0.2$

$= -13.98\text{ dB} = -14\text{ dB}$

2. a) A filter has a transfer function $H_1(j\omega) = \frac{10 + j\omega}{j\omega}$. What is the magnitude $|H_1|$ of this transfer function [or the amplitude of (H_1)] at ω = 20 rad/s ?

$|H_1|$ = ______________________

$$|H_1| = \frac{|10+j20|}{|j20|} = \frac{\sqrt{10^2+20^2}}{20} = 1.12$$

b) What is the phase of this transfer function [or the angle(H_1)] at ω = 20 rad/s ?

angle(H_1) = ______________________

$$\text{angle}\left(\frac{10+j20}{j20}\right) = \text{angle}(10+j20) - \text{angle}(j20)$$

$$= \tan^{-1}\frac{20}{10} - 90^\circ$$

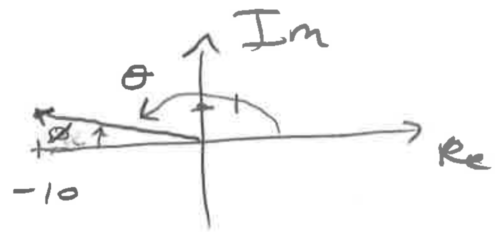
$$= 63.4^\circ - 90^\circ = -26.6^\circ$$

3) What are the magnitude and phase of the complex number −10 + j1 ?

a) magnitude or amplitude = ______________________ (***not*** in dB)

$$|-10+j1| = \sqrt{-10^2+1^2}$$

$$= 10.05$$



b) Phase or angle = __________________________ degrees

$$\phi = \tan^{-1}\frac{1}{10} = 5.7°$$

$$\theta = 180 - \phi = 174.3°$$

complex number in 2nd quadrant

4: In lab, the signal generator is outputting a sinusoidal signal:
$v(t) = B\cos(100t + 70^o)$. You measure this signal using a Digital Multimeter (DMM) and the DMM reads $2.0V_{rms}$.

a) What is the peak voltage of this sinusoidal signal? ______________

$$\frac{peak}{\sqrt{2}} = rms$$

$$\Rightarrow peak = \sqrt{2}(rms) = \sqrt{2}(2.0) = 2.83V = B$$

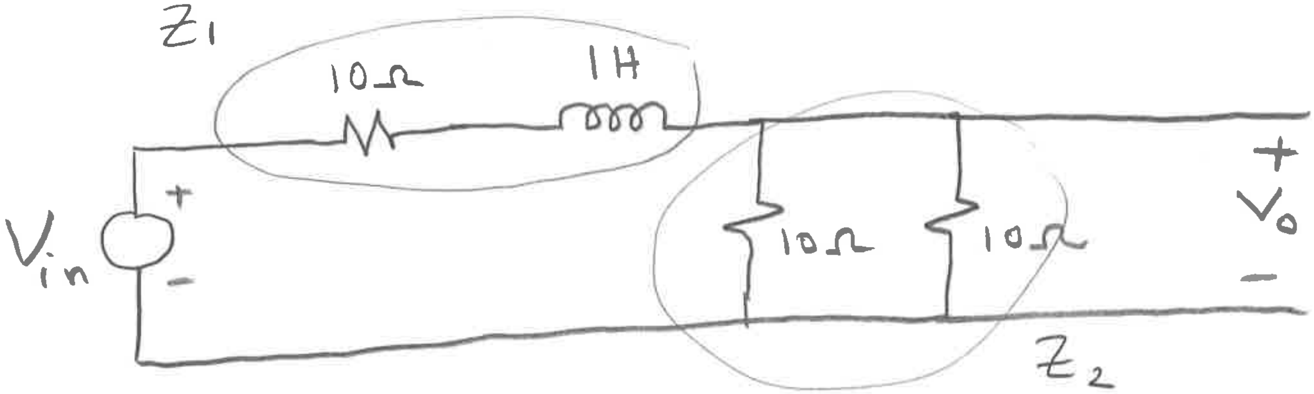
b) What is the phasor representation for this signal? ______________

$$\tilde{V} = B\angle 70^\circ = 2.83\angle 70^\circ$$

$$\text{or } 2.83e^{j70^\circ}$$

5. Find the transfer function $\mathbf{H}(j\omega) = \mathbf{V_o}(j\omega)/\mathbf{V_{in}}(j\omega)$ for the circuit below. (The answer should be in the form of a ratio of two complex expressions like 'a + jb', where a and/or b may be a function of ω.)

H(jω) = ______________________________



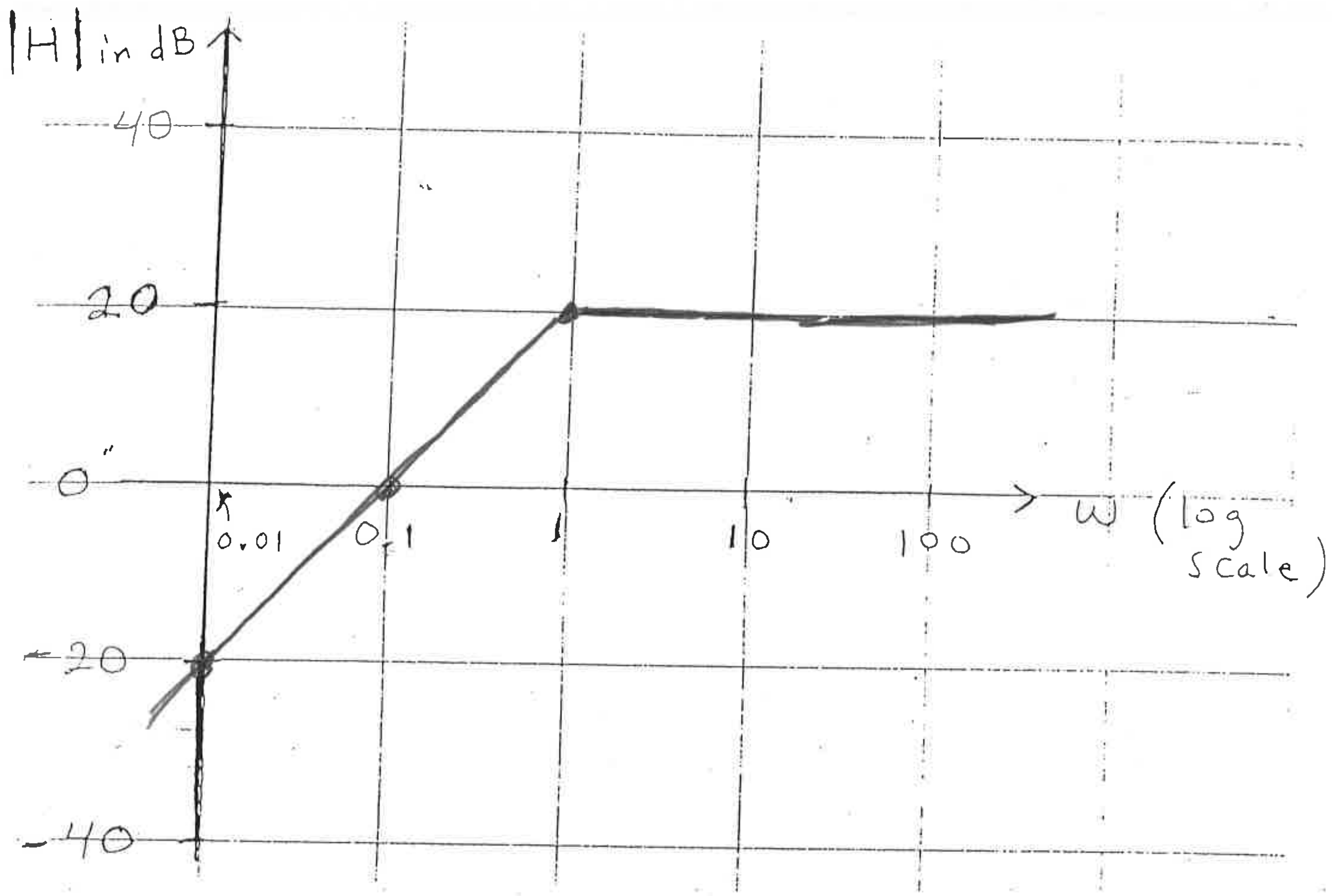
$Z_1 = 10 + j\omega 1 = 10 + j\omega$

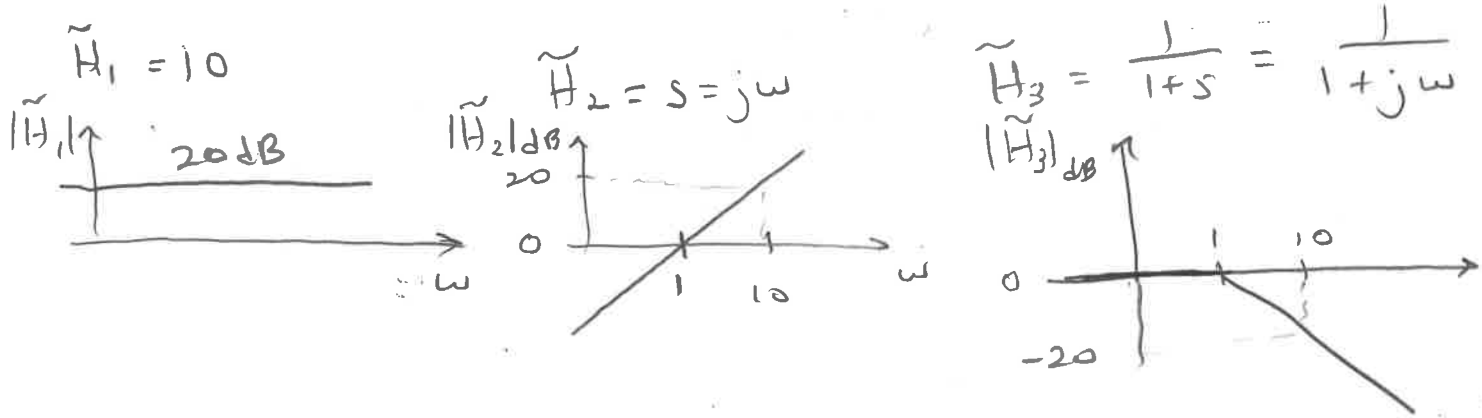
$Z_2 = \frac{10 \cdot 10}{10 + 10} = 5\Omega$

$$\tilde{H} = \frac{V_o}{V_{in}} = \frac{Z_2}{Z_1 + Z_2} = \frac{5}{10 + j\omega + 5}$$

$$= \frac{5}{15 + j\omega}$$

6. a) Draw the approximate Bode magnitude (or amplitude) plot [|H| in dB vs. ω on a log scale] for the transfer function $H(s) = \frac{10s}{1+s}$. (Set s = jω.) (A Bode plot using only straight-line segments is requested here.)

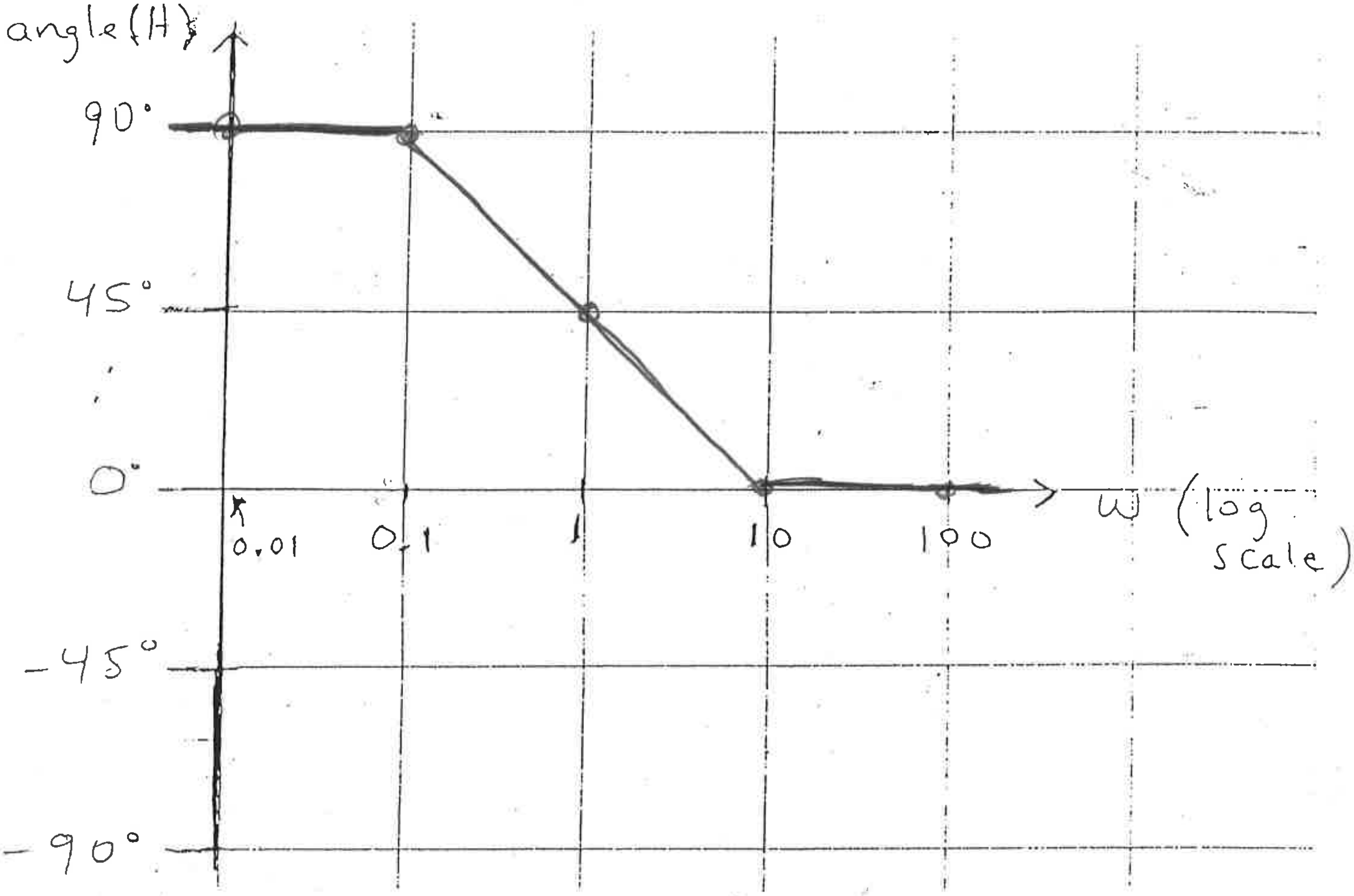


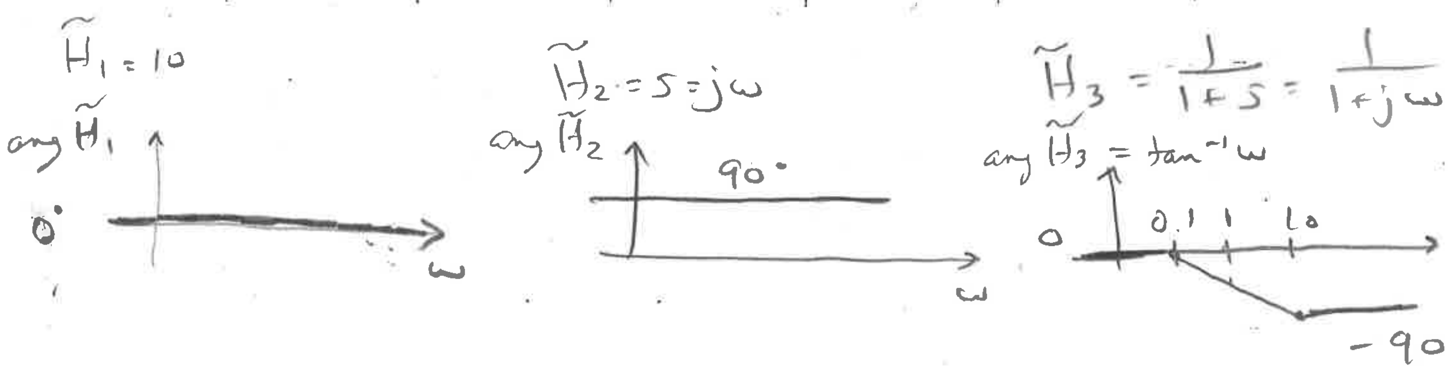


add these 3 plots to get answer

6 (continued)

b) Draw the approximate Bode phase (or angle) plot [angle(H) vs. ω on a log scale] for the transfer function $H(s) = \frac{10s}{1+s}$. (Set s = jω.) (A Bode plot using only straight-line segments is requested here.)



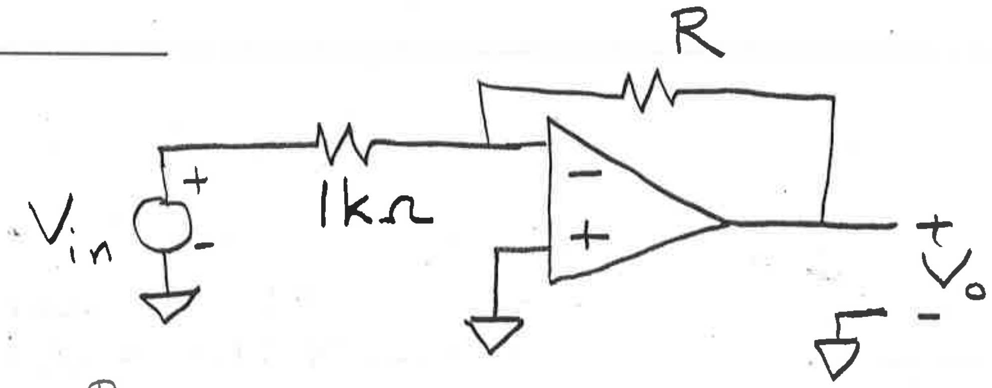


add these 3 plots

7. In the circuits below, assume the op amp is ideal.

a) For the circuit below, what R value gives Vo / Vin = –12

R = _______________

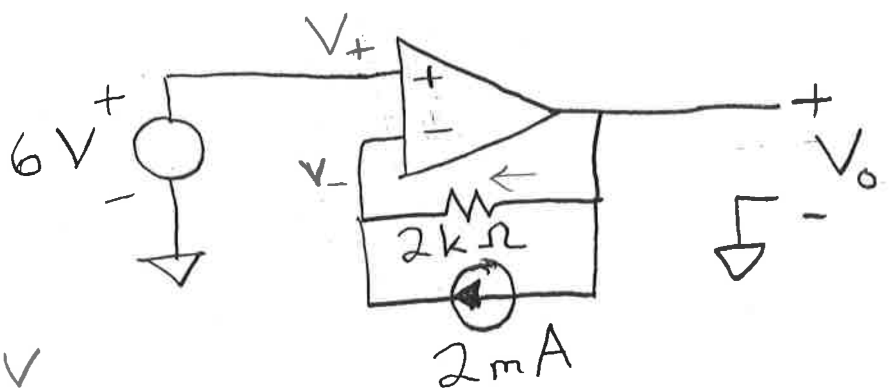


$$\frac{V_o}{V_{in}} = -\frac{R}{1k\Omega} = -12$$

$$\Rightarrow R = 12k\Omega$$

b) For the circuit below, what is the output voltage, Vo ? (The current source and voltage source are DC sources.)

Vo = _______________



$$V_+ = V_- = 6V$$

$$\text{KCL: } 2mA + \frac{V_o - V_-}{2k\Omega} = 0$$

$$\Rightarrow V_o = -2mA(2k\Omega) + V_-$$

$$= -4V + 6V = 2V$$