10 pt max: ASEN3300 **Prelab Quiz 4**

Name: Solutions Lab Station: ______ 8 / 10 AM ______

2 pts.

1. A sinusoidal signal with an amplitude of V_{in} = 10 V is input to a circuit, and gets attenuation of -20 dB. What is the amplitude of the resulting output signal V_{out}?

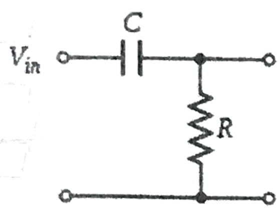
+1 $-20\,dB = 20 * \log\left(\frac{V_{out}}{V_{in}}\right) \Rightarrow -1 = \log\left(\frac{V_{out}}{V_{in}}\right)$

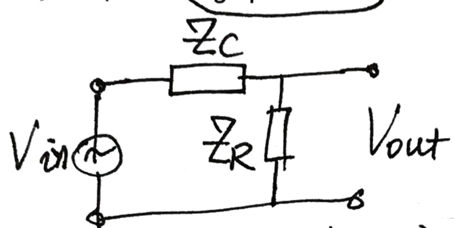
$\Rightarrow V_{out} = 10^{-1} \cdot V_{in} = 10^{-1} * 10 = 1\,V$ +1

4 pts.

2. For a RC filter circuit below, the input is V_{in} and the output is V_{out}. Write out the complex impedance of the capacitor and resistor in the frequency domain, and then derive the transfer function of this circuit. (Transfer function is defined as $H(\omega) = \frac{V_{out}}{V_{in}}$, and its magnitude is $|H(\omega)| = \left|\frac{V_{out}}{V_{in}}\right| = \frac{|V_{out}|}{|V_{in}|}$.) Identify what kind of filter this circuit is, basically low-pass or high-pass filter?

+1 This is a high-pass filter.





$\left.\begin{array}{l} Z_C = \frac{1}{j\omega C} \\ Z_R = R \end{array}\right\}$ +1

$V_{out} = \frac{Z_R}{Z_C + Z_R} V_i \Rightarrow H(\omega) = \frac{V_{out}(\omega)}{V_{in}(\omega)} = \frac{Z_R}{Z_C + Z_R}$

+2 $\Rightarrow H(\omega) = \frac{R}{\frac{1}{j\omega C} + R} = \frac{j\omega RC}{1 + j\omega RC}$. $|H(\omega)| = \frac{\omega RC}{\sqrt{1 + (\omega RC)^2}}$

Not Required

4 pts.

3. A sinusoidal wave with frequency of 1 kHz and peak amplitude of 1 V is input to a RC low-pass filter as V_i, and the RC circuit has the following transfer function: $H(\omega) = \frac{V_o}{V_i} = \frac{\omega_0}{\omega_0 + j\omega}$, where $\omega_0 = 2\pi f_0$ and $f_0 = 500\,Hz$ is the -3dB frequency and ω represents angular frequency.

a) How much are the frequency and amplitude of the output signal V_o?
 (*Hint: consider the transfer function magnitude*)

b) If the resistor is R = 3183 Ω, then what capacitance is needed to make the -3 dB frequency to be 500 Hz?

+1 a) The frequency of output signal V_o is the same as the input : 1 KHZ

b) $|V_o| = |H(\omega) V_i| = |H(\omega)| \cdot |V_i|$

+2 $= \left|\frac{\omega_o}{\omega_o + j\omega}\right| \cdot |V_i| = \frac{1}{\sqrt{1 + (\omega/\omega_o)^2}} \cdot |V_i|$

$= \frac{1}{\sqrt{1 + (f/f_o)^2}} \cdot |V_i| = \frac{1}{\sqrt{1 + (1000/500)^2}} \cdot 1V = 0.447V$

+1 c) $\omega_o = 2\pi f_o = \frac{1}{RC} \Rightarrow C = \frac{1}{2\pi f_o R} = \frac{1}{2\pi \times 500 \times 3183} = 1 \times 10^{-7}\,F = 0.1\,\mu F$.