1. The switch is closed at $t = 0$. (a) In terms the component values $R_1$, $R_2$, and $C_2$, what is $V_{out}(t)$ at $t = 0^+$? (b) What is $V_{out}(t)$ as $t \to \infty$? (c) Derive the time dependence for $V_{out}(t)$.

Consider steady-state conditions of the above circuit. (a) In terms of $V_{in}(\omega)$ and the component values $R_1$, $R_2$, and $L_2$, what is $V_{out}(\omega)$ as $\omega \to 0$? (b) What is $V_{out}(\omega)$ as $\omega \to \infty$? (c) What is the general relation between of $V_{out}(\omega)$ and $V_{in}(\omega)$?

2. The switch is closed at $t = 0$. (a) In terms the component values $R_1$, $R_2$, and $C_2$, what is $V_{out}(t)$ at $t = 0^+$? (b) What is $V_{out}(t)$ as $t \to \infty$? (c) Derive the time dependence for $V_{out}(t)$.

3. Consider steady-state conditions of the above circuit with $RC' >> RC$. (a) Sketch a Bode plot of the magnitude of $\tilde{V}_{out}(\omega)/\tilde{V}_{in}(\omega)$, i.e., $\log_{10}(\tilde{V}_{out}(\omega)/\tilde{V}_{in}(\omega))$ versus $\log_{10}(\omega)$, labeling the slopes and the break points, i.e., -3dB points, terms of the component values $R$, $C'$, and $C$. (b) Sketch a Bode plot of the phase of $\tilde{V}_{out}(\omega)/\tilde{V}_{in}(\omega)$, i.e., $\arg(\tilde{V}_{out}(\omega)/\tilde{V}_{in}(\omega))$ versus $\log_{10}(\omega)$. (c) Derive expressions for the magnitude and phase between of $\tilde{V}_{out}(\omega)$ and $\tilde{V}_{in}(\omega)$.
4. 

Consider steady-state conditions of the above circuit with the frequency-dependent open-loop amplifier gain, $\tilde{A}(\omega)$ and recall that $\tilde{V}_{\text{out}}(\omega) = \tilde{A}(\omega)[\tilde{V}^+(\omega) - \tilde{V}^-(\omega)]$.  

(a) Write an expression for $\tilde{V}_{\text{out}}(\omega)$ in terms of $\tilde{I}(\omega)$ that takes into account the gain of the operational amplifier.  

(b) Write an expression for $\tilde{Z}_{\text{in}}(\omega)$ as seen by the current source that takes into account the gain of the amplifier.  

(c) Using the data for $\tilde{A}(\omega)$, sketch a plot of $\log_{10}\{\tilde{Z}_{\text{in}}(\omega)\}$ versus $\log_{10}\{\omega\}$. 

5. 

Consider the diode circuit.  

(a) For an ideal diode that conducts with zero resistance above $V_D = 0.7$ V, but does not conduct below this potential, plot $V_{\text{out}}(t)$ for two cycles.  

(b) For a realistic diode with $I_D = I_0 [\exp(qV_D/KT) - 1]$ and $I_0 = 0.1$ µA and $KT/q = 25$ mV, what is the lowest value of the resistance of the diode during the cycle?  

(c) What is the highest value? 

Extra credit 

What is the Fourier transform of a pulse, given by $V(t) = \begin{cases} 0 & \text{for } t < -T/2 \\ 1/T & \text{for } -T/2 \leq t \leq T/2 \\ 0 & \text{for } t > T/2 \end{cases}$? 

Recall: $\tilde{V}(\omega) = \int_{-\infty}^{\infty} dt \ V(t) \exp(-i\omega t)$; $\sin\{x\} = (1/2i) \ \{\exp(i\omega t) - \exp(-i\omega t)\}$. Hint: mind the limits!