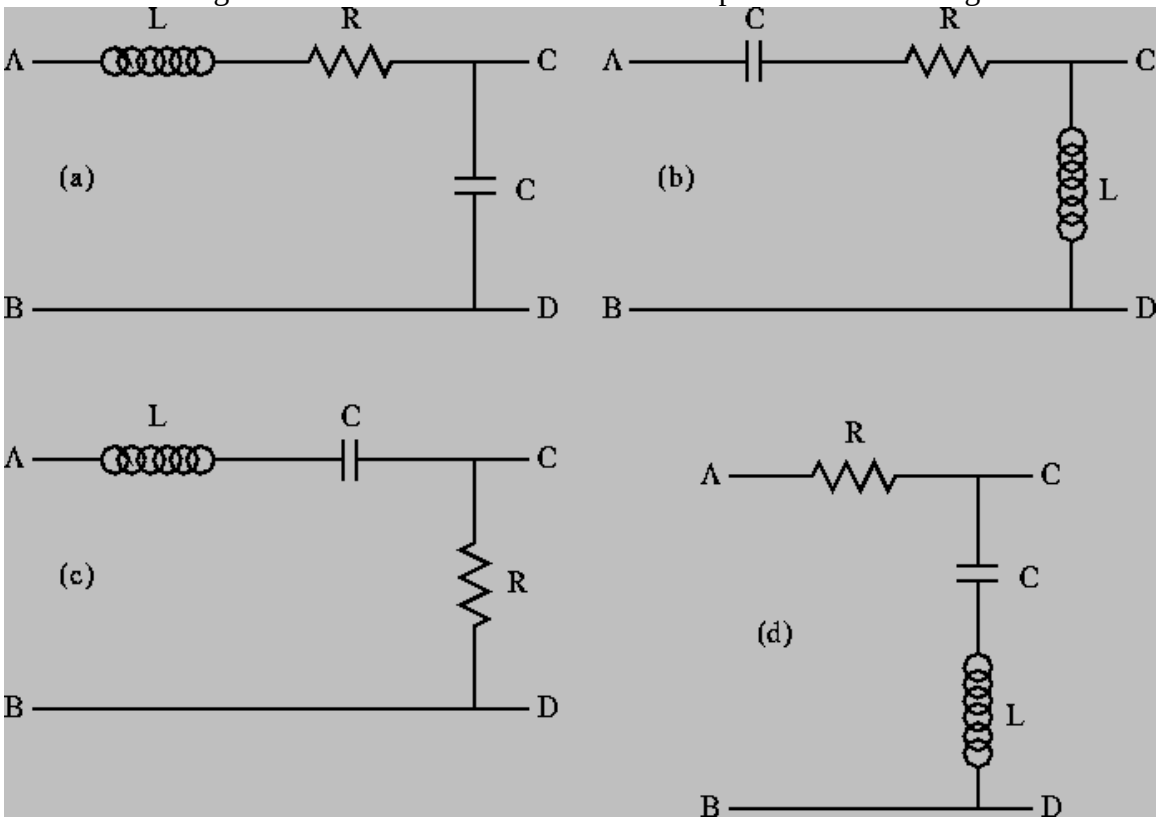
Electronics and Instrumentation

Name _____ ENGR-4220 Fall 1998 Section _____

Quiz 2

1. **RLC Circuits**

You should recognize the circuits shown below from Experiment 5 and Gingrich's notes.



Given below are several possible expressions for transfer functions for such circuits. Indicate which circuit goes with which function.

$$V_{out}/V_{in} = H(j\omega) = j\omega L/(R + j\omega L + 1/j\omega C)$$

$$V_{out}/V_{in} = H(j\omega) = R/(R + j\omega L + 1/j\omega C)$$

$$V_{out}/V_{in} = H(j\omega) = 1/(j\omega C)(R + j\omega L + 1/j\omega C)$$

$$V_{out}/V_{in} = H(j\omega) = 1/(R + j\omega L + 1/j\omega C)$$

$$V_{out}/V_{in} = H(j\omega) = (j\omega L + 1/j\omega C)/(R + j\omega L + 1/j\omega C)$$

$$V_{out}/V_{in} = H(j\omega) = (R + j\omega L)/(R + j\omega L + 1/j\omega C)$$

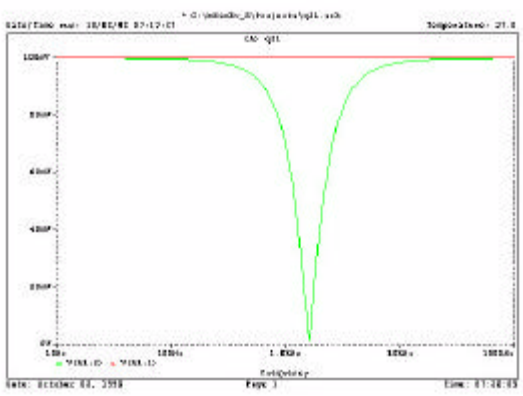
$$V_{out}/V_{in} = H(j\omega) = (R + 1/j\omega C)/(R + j\omega L + 1/j\omega C)$$

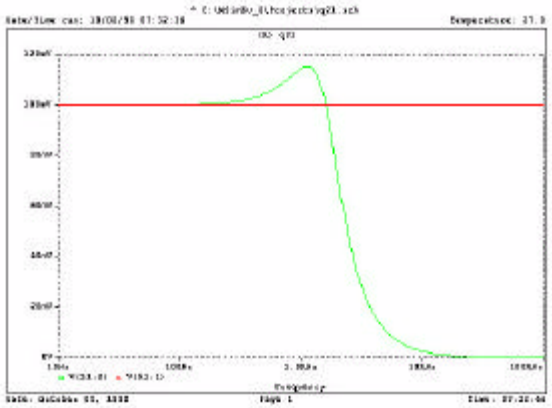
$$V_{out}/V_{in} = H(j\omega) = (R + j\omega L + 1/j\omega C)/(R + j\omega L + 1/j\omega C)$$

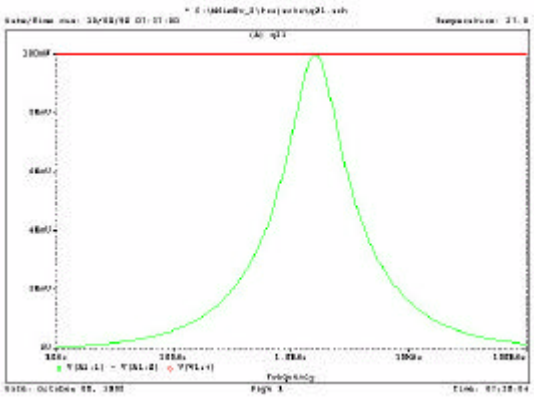
Since all four circuits are series RLC, they all have the same resonant frequency ω_o. What is the expression for this frequency?

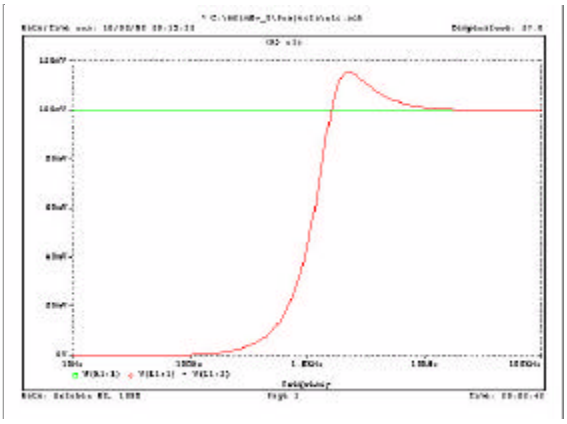
Determine the complex transfer function for each of the four circuits at the resonant frequency. Be sure your answer is given in terms of R, L, and C and does not contain ω. This may seem like an obvious comment, but we want to be sure that you have the simplest possible expression. Identify the magnitude and the phase of the transfer function at this frequency.

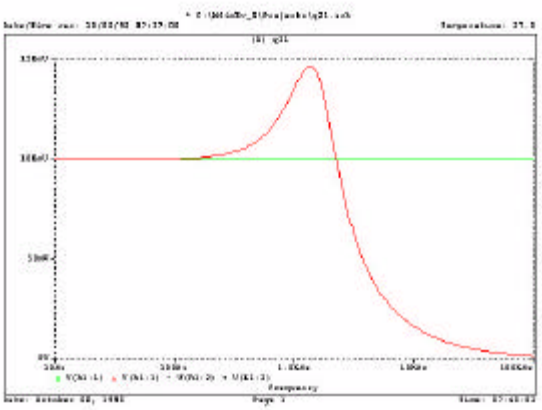
Below are six plots, which are all made from an AC Sweep analysis of a series RLC circuit in which R = 1kΩ, L = 100mH, and C = 0.1μF. Identify which plot goes with each of the circuit configurations on the previous page. Be sure you explain your answer in each case, since partial credit will be given if at least part of your reasoning is correct. *Hint: The last two plots are not correct for any circuit. Can you explain why?*

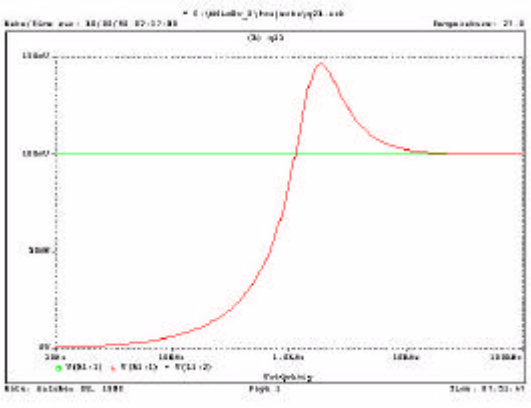








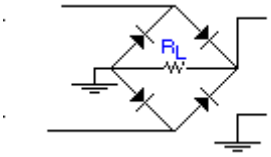




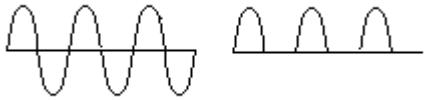
2. **Diode Circuits**

Below are two diode circuit configurations and two figures showing the input and ideal output voltages for these circuits. Indicate which input/output voltage pairs go with which circuit. Also, one circuit is a half-wave rectifier and one is a full-wave rectifier. Label which is which.

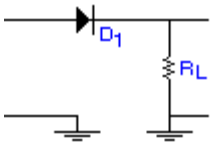
Circuit One



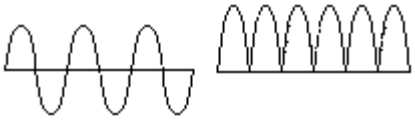
Input Voltage Output Voltage



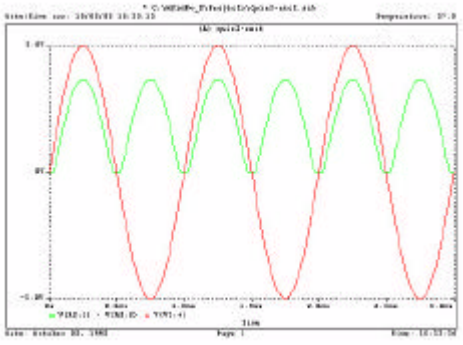
Circuit Two

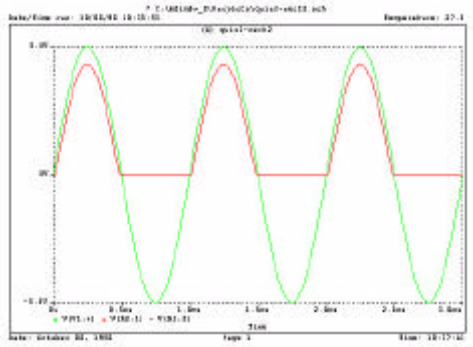


Input Voltage Output Voltage



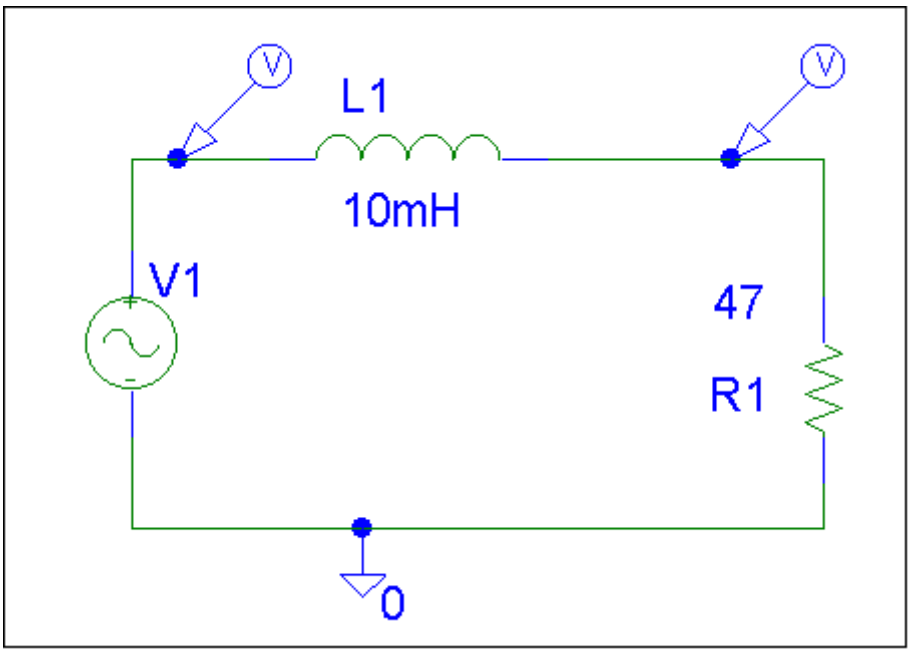
When we use PSpice to simulate the response of a real diode (1N4148, for example) we obtain a slightly different output response. Shown below are Probe plots for these two circuits configured with 1N4148 diodes and 1kΩ resistors. Again, label which goes with which circuit. Then note and explain any differences between the ideal and more realistic response obtained from PSpice. Just for reference purposes, the input voltage in the two cases below is 10 volts peak-to-peak.





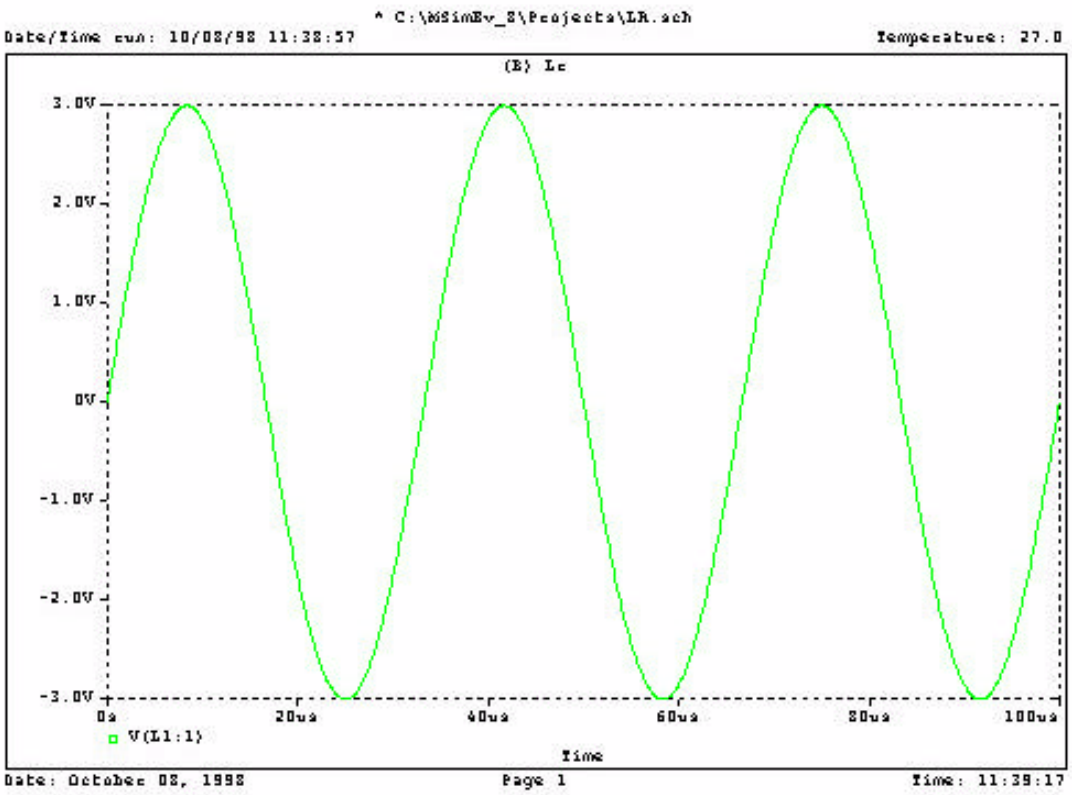
3. **Filters**

The following circuit consists of a sinusoidal source, an inductor and a resistor.



If V_{in} is the sinusoidal source and V_{out} is the voltage across the resistor, is this configuration a high-pass filter, a low-pass filter or neither? Explain your answer.

The source is a sinusoidal voltage with some amplitude and frequency. The source voltage, as a function of time, is shown on the next page. Write out the mathematical expression for this voltage function in the form $V_{in} = V_o \sin(\omega t + \phi_o)$. Be sure that you give values for V_o, ω, and ϕ_o.

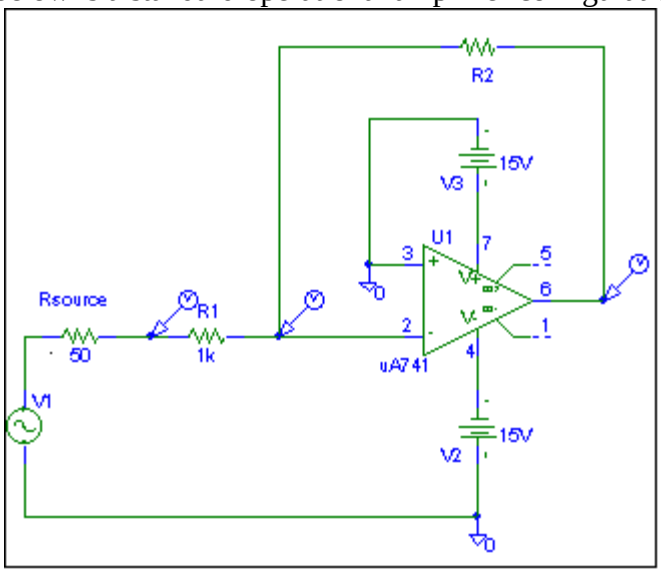


Now that you have determined the magnitude, frequency and phase of the input voltage, you should have some idea of what will happen at the output. From your knowledge of the corner frequency for this circuit, will the output voltage be about the same as the input, substantially smaller or substantially larger than the input? Explain your answer.

Would you say that, for this circuit, the frequency of the source is high or low?

4. **Operational Amplifiers**

The circuit shown below is a standard operational amplifier configuration.



Is it an inverting amplifier, a non-inverting amplifier or a differential amplifier?

If the amplitude of V1 is 100mV, what value of R2 should we choose to make the magnitude of the output approximately equal to 3V?