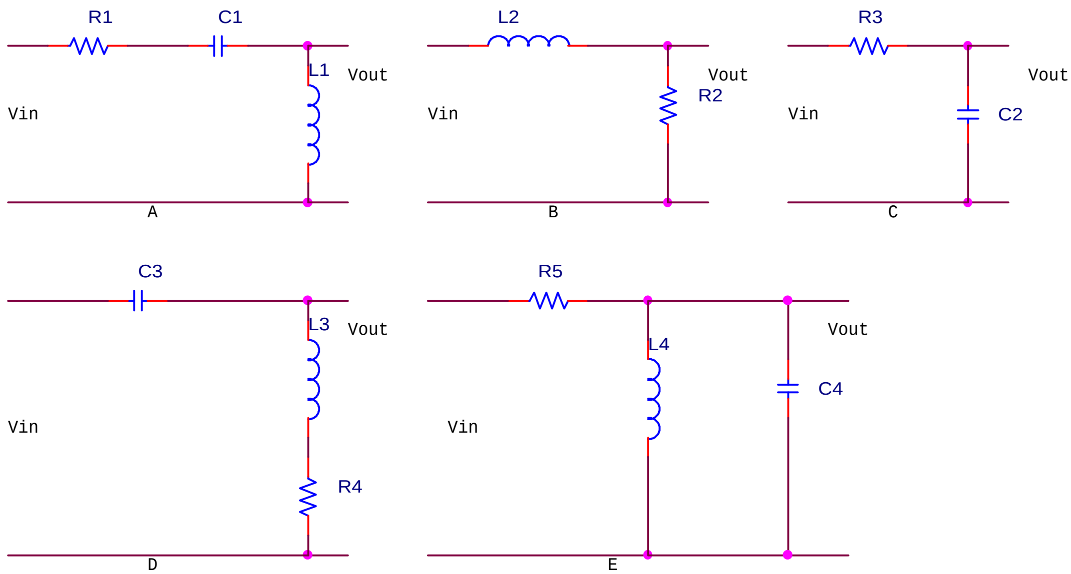
Electronics and Instrumentation

Name ________________ ENGR-4220 Fall 1999 Section _____________

Quiz 2a

1. **RLC, RL and RC Circuits**

Shown below are 5 circuits. Assume that an input voltage (V_{in}) is applied across the left-most terminals and the output voltage (V_{out}) is measured across the right-most terminals.



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

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

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

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

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

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

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

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

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

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

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

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

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

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

Find the resonant frequency ω_o for the RLC circuits and the corner frequency ω_c for the other circuits. That is, write the general expression for each frequency.

Determine the complex transfer function for each of the five circuits at the resonant or corner frequency. Be sure your answer is given in terms of R, L, and/or 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.

A. $V_{out}/V_{in} = H(j\omega_o) =$

B. $V_{out}/V_{in} = H(j\omega_c) =$

C. $V_{out}/V_{in} = H(j\omega_c) =$

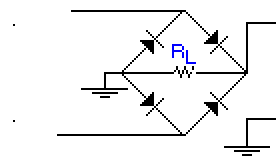
D. $V_{out}/V_{in} = H(j\omega_o) =$

E. $V_{out}/V_{in} = H(j\omega_o) =$

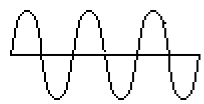
2. **Diode Circuits**

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.

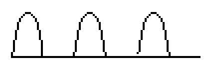
Circuit One



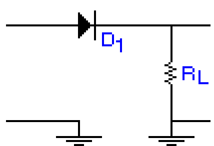
Input Voltage



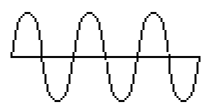
Output Voltage



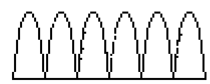
Circuit Two



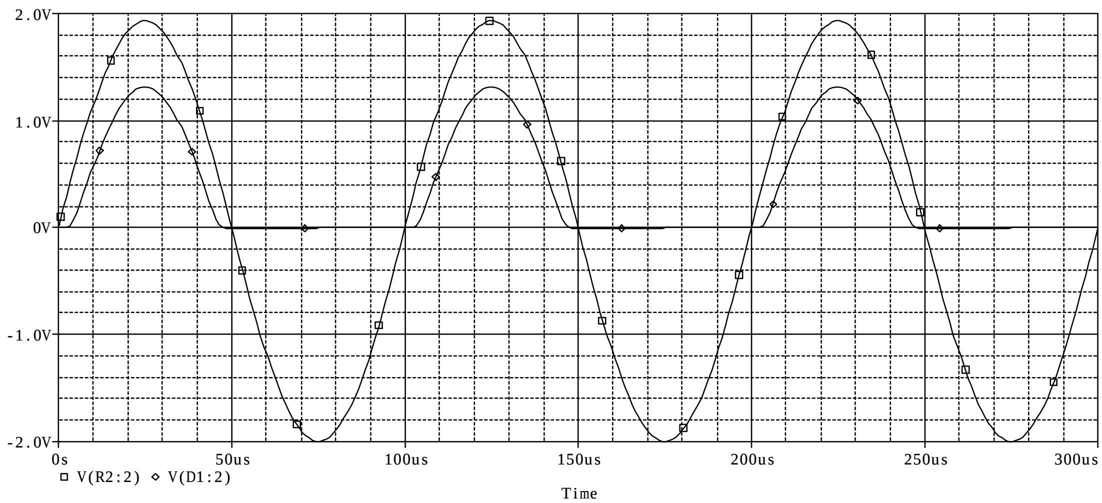
Input Voltage

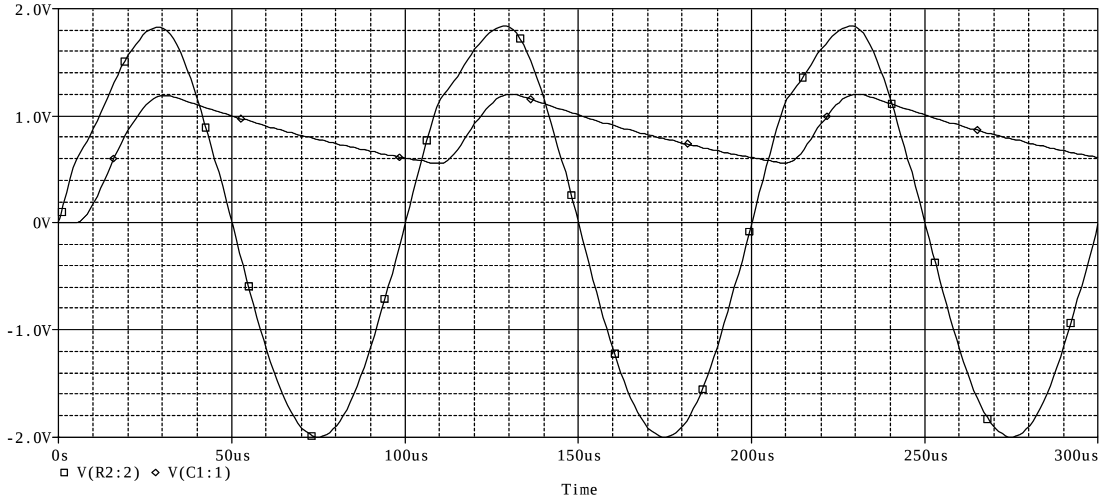


Output Voltage



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 one of these two circuits configured with 1N4148 diodes and 1kΩ load resistors. The source is a function generator with a 50Ω internal impedance. In one case we have added a 0.1µF smoothing capacitor.





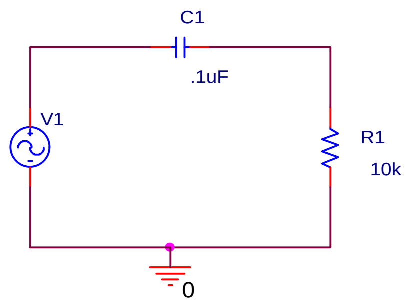
Which type of rectifier is being modeled?

For the rectifier without smoothing, note and explain any significant differences between the response of the ideal rectifier and a rectifier using real components.

Why is the configuration with smoothing better than without? Can you see any problems caused by the smoothing capacitor?

3. **Filters**

The following circuit consists of a sinusoidal source, a capacitor 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.

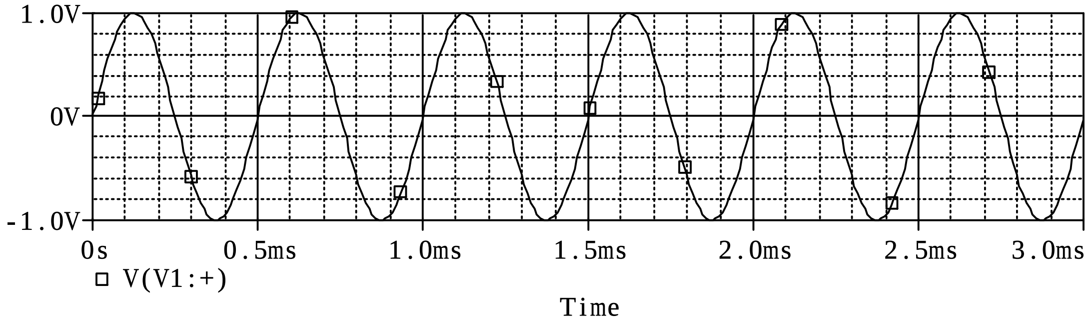
The source is a sinusoidal voltage with some amplitude and frequency. The source voltage, as a function of time, is shown on the next page. Write out the mathematical expression for this voltage function in the form $V_{in} = V_o \sin(\omega t + \phi_o)$. Be sure that you give values for V_o, ω, and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

$V_o =$

$\omega =$

$\phi_o =$

$V_{in} =$

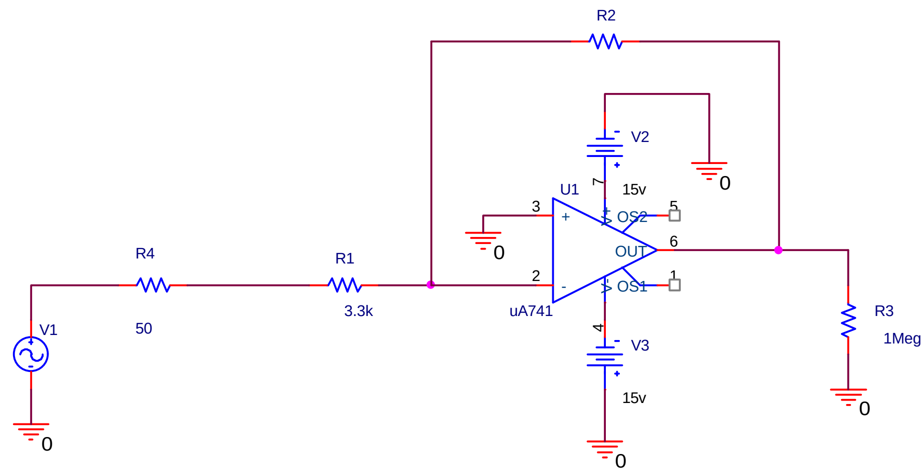


Now that you have determined the magnitude, frequency and phase of the input voltage, you should have some idea of what will happen at the output. From your knowledge of the corner frequency for this circuit, will the output voltage be about the same as the input, substantially smaller or substantially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

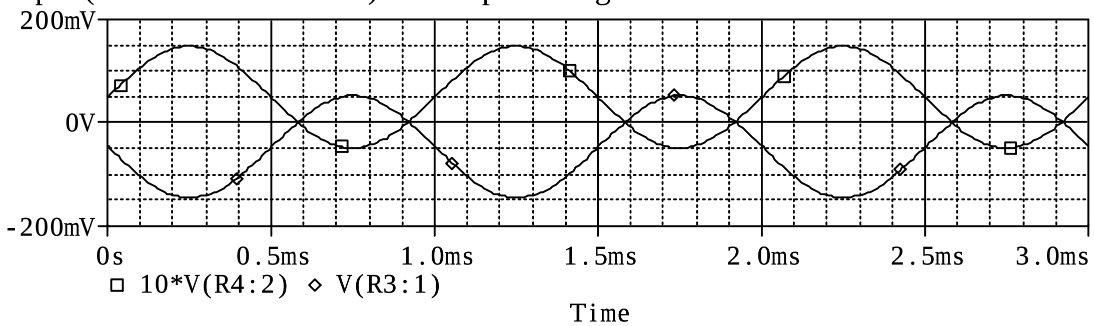
Would you say that, for this circuit, the frequency of the source is high or low? Roughly sketch the magnitude of the transfer function for this circuit as a function of frequency.

4. **Operational Amplifiers**

The circuit shown below is a standard operational amplifier configuration.



The input (after the 50Ω resistor) and output voltages are shown below.



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

What value of resistor R2 was used to produce this plot?