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1. 555 Timer (20 points)

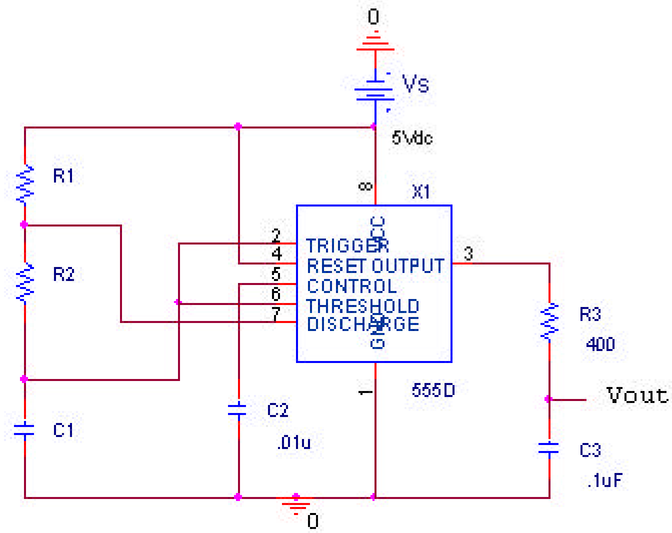

Figure 1: 555 Timer Circuit

For the 555 timer circuit in Figure 1, find the following values for R1 = 1K, R2 = 2K, C1 = 0.1uF. Show all work.

a) (4 points) T1:

b) (4 points) T2:

c) (4 points) Duty cycle:

d) (4 points) Frequency:

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In project 2 we connected the audio input through a capacitor to the control voltage pin (i.e., pin 5). Just as in project 2, we now remove C2 and connect a signal source through a capacitor to pin 5. We denote the control voltage V_{CTL}. The upper threshold then becomes $2V_S/3 + V_{CTL}$.

e) As V_{CTL} increases, does the charge time increase, decrease or stay the same? Why? (3 points)

f) As V_{CTL} decreases, does the frequency of the pulses output from pin 3 increase, decrease, or stay the same? Why? (3 points)

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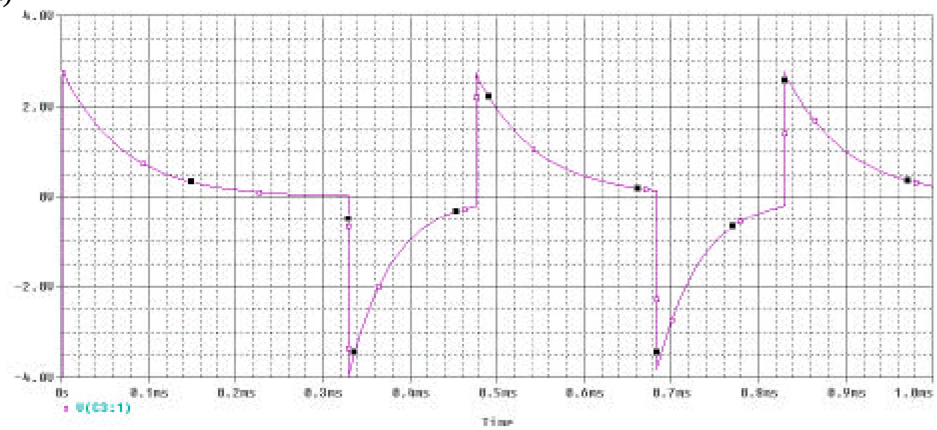
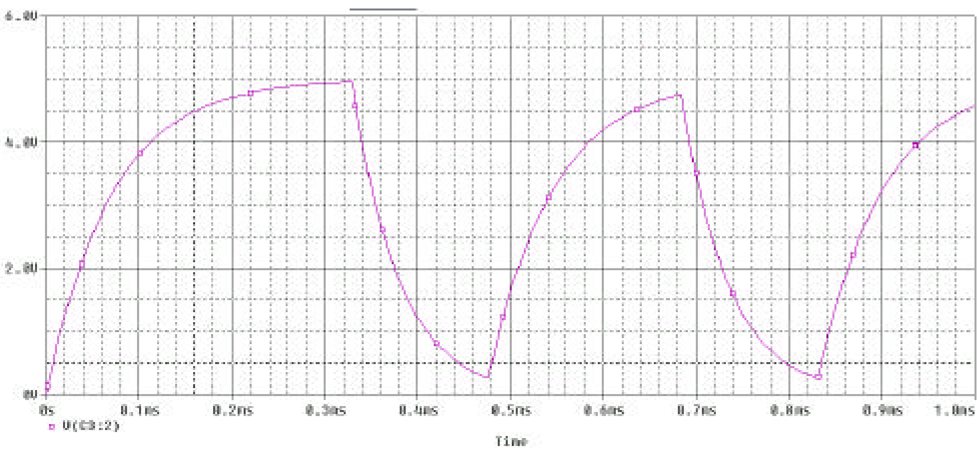
Extra Credit (1 point) : Using your knowledge of RC circuits and assuming the capacitor is discharged at time 0, circle the plot corresponding to the shape of Vout.

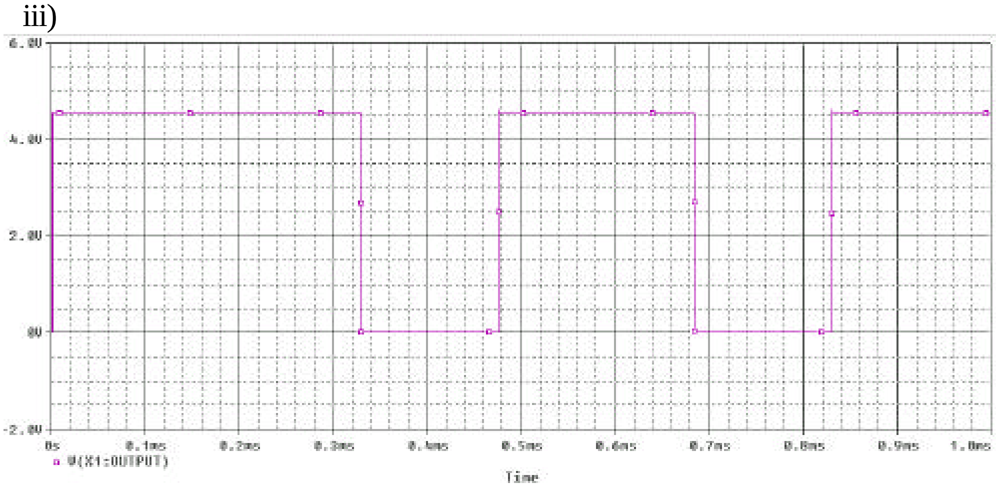
i)



ii)



iii)



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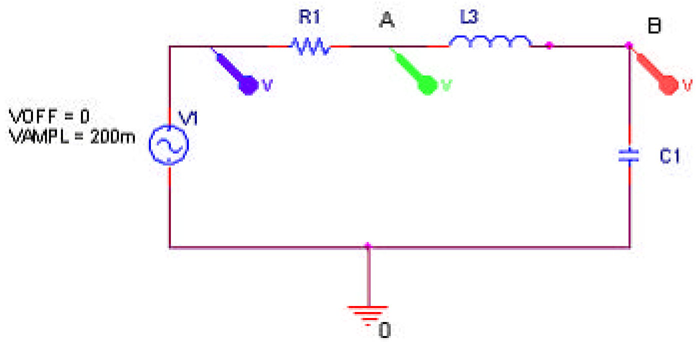
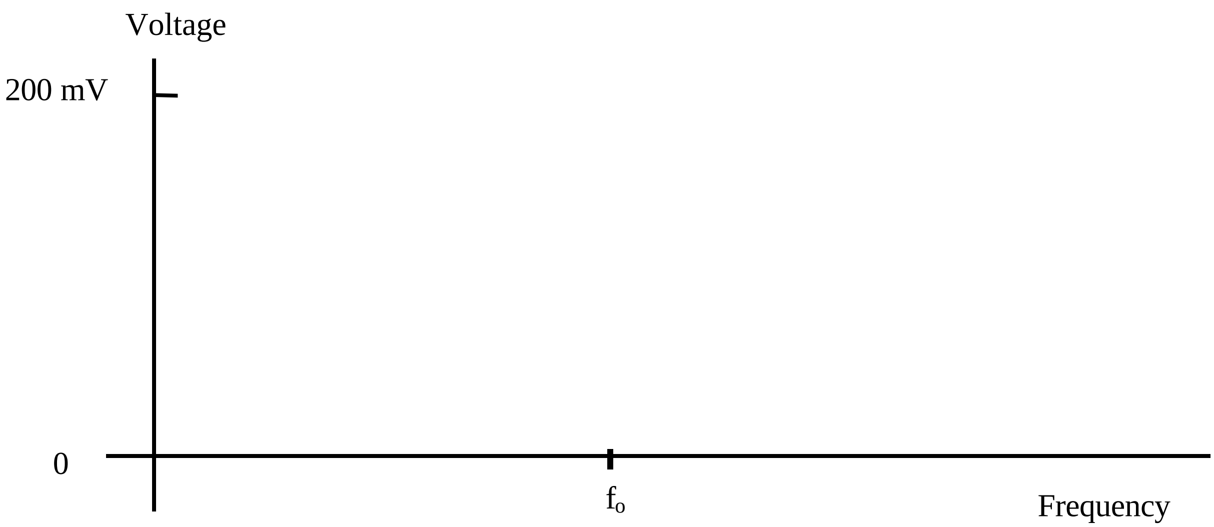
2. Inductance Measurement (20 points)

In the circuit below, Vin = 200mV, R1 = 300Ω, C1 = 0.05μF and L1 is unknown.



a) If you perform AC Sweep of the voltages at points A and B, illustrate both traces in the space below where the resonance frequency f_o is 40 kHz (please label the traces A and B, respectively). 6 points



b) Explain why the two traces behave at very low and very high frequencies the way you illustrated above, respectively. You can explain in details using either transfer function of the circuit or open/short approximation for capacitor and inductance. (6 points)

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c) Solve for the unknown inductance from information obtained from the figure above. (6 points)

d) Discuss how the figure would be different if the locations of the capacitor and inductor in the circuit are switched. (2 points)

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3. Zener Diodes (20 points)

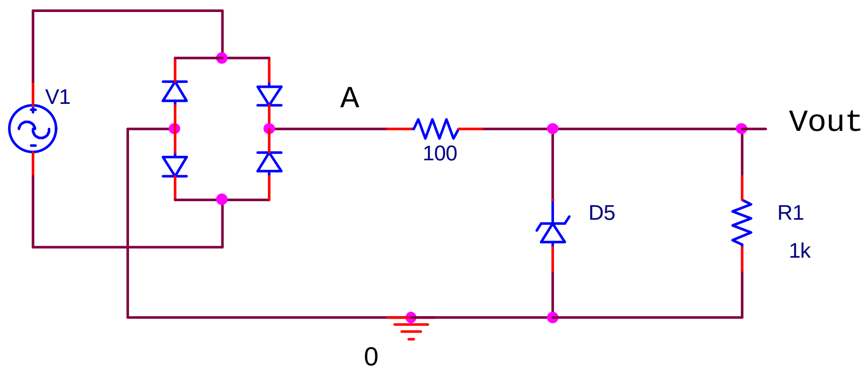
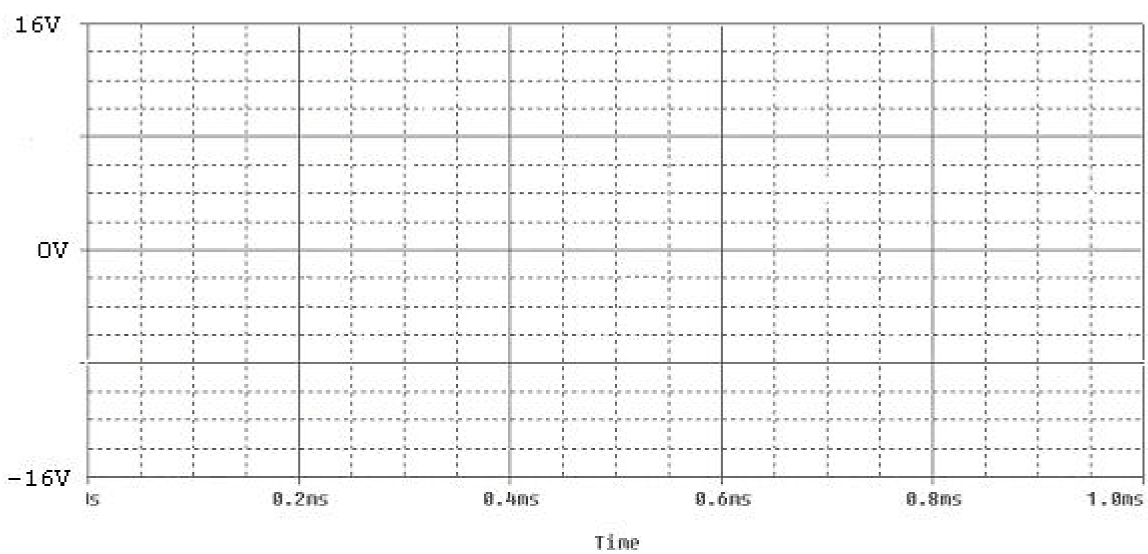


Figure 2: Zener Diode Circuit

In Figure 2, the voltage V1 is sinusoidal with frequency 2 kHz with an amplitude of 15 volts. The Zener diode has a Zener voltage of 5V and the non-Zener diodes have a threshold voltage of 0.6 V.

a) Draw the V1 and V_{out}. Clearly *label* the Zener region. (12 points)



c) What description best fits this circuit? (Circle one) (8 points)

i) Inverter and half-wave rectifier.

ii) Voltage regulator with full-wave rectifier.

iii) Voltage regulator with half-wave rectifier.

iv) Integrator and voltage regulator.

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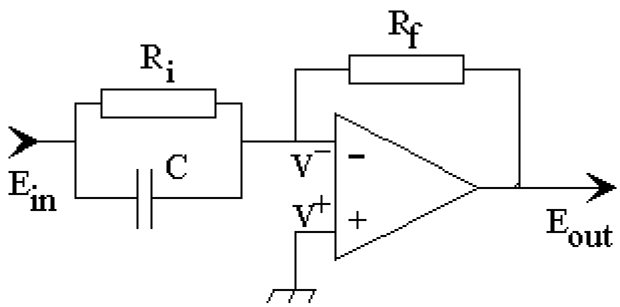
4. Op-amp Analysis (20 points)

The circuit below shows an op-amp differentiator which has been modified by the addition of a resistor in parallel with the input capacitor.



a) What are the two rules for op-amp analysis (2 pnts)?

b) Using these two rules you have stated above, find the transfer function for the above circuit H(jù) = Eout/Ein. You must show your work! (10 pnts)

c) Use the transfer function from b) to find how the circuit behaves at low frequencies. Give the function in terms of ù (2 pnts), the magnitude (1 pnt) and the phase (1 pnt).

d) Use the transfer function from b) to find how the circuit behaves at high frequencies. Give the function in terms of ù (2 pnts), the magnitude (1 pnt) and the phase (1 pnt).

Extra credit (1 pnt): Is this a good differentiator? Why or why not?

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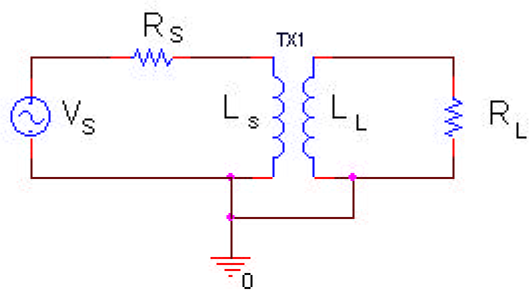
5. Transformer (20 points)

In the circuit, the Vs is 100 mV, R_s has negligible amount of resistance, the R_L is 500 ohms.



a) Assuming a perfect matching and coil L_s has 50 turns, how many turns L_l has to have in order to obtain voltage of 1 volt across the load R_L? (6 points)

b) What is the impedance Zin of Ls? (6 points)

c) What is the current in the loop containing the load? (4 points)

d) Assuming a non-ideal transformer, list two transfer design methods (only) that would increase the voltage output at the load. (4 points)