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**EEE 202 Lab 6 Data Sheet**

**AC Analysis**

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| **Part 1 (15 pts): Prelab Calculations and LTSpice Simulation Work** |
| **Question 1 – Resistive Circuits**  **Build this circuit in LTspice and run a Transient Analysis (.tran) for 10ms:**    **Include a screenshot of the LTSpice circuit here (Have a look at an example screenshot at the end of this document):** |
| **Simulate in LTspice. Plot the voltage across R1 (N1-N2) and the current (left to right). Make sure the voltage and current curves are plotted on the same plot.**  **Screenshot of LTSpice Plot - Make sure that your computer’s date and time are showing up in your screenshot:** |
| **Is the current in-phase or out-of-phase with the voltage? Why do you think this is the case?** |
| **Question 2 (RC – Pulse Source):**   1. **What is the expression for the current, *i*(*t*):**   **Show your steps.**  **Steps (handwritten or typed):**  **i(t) =** |
| 1. **What are the expressions for the voltages across the resistor, vR(t) and the capacitor, vC(t):**   **Show your work.**  **Steps (handwritten or typed):**  **vR(t) =**  **vC(t) =** |
| 1. **Create a simulation of your RC circuit in LTSPICE.**   **Include a screenshot of the LTSpice circuit here (Have a look at an example screenshot at the end of this document):** |
| 1. **Create plots of your RC circuit in LTSPICE (*i(t), vR(t), and vC(t) all on the same plot*)**   **Screenshot of LTSpice Plot - Make sure that your computer’s date and time are showing up in your screenshot:** |
| 1. **Repeat the LTSpice simulations you carried out in question 1 but with tON, rise time, fall time, and the period all reduced by a factor of 10.** 2. LTSpice circuit schematic screenshot   **Include a screenshot of the LTSpice circuit here (Have a look at an example screenshot at the end of this document):** |
| 1. Include the plot of i(t), vR(t), and vC(t) (all on the same plot).   **Screenshot of LTSpice Plot - Make sure that your computer’s date and time are showing up in your screenshot:** |
| **Question 3 – RC – Sinusoids):**   1. **Create a simulation of your RC circuit and plots of (*vS(t), vR(t), and vC(t)*) in LTSPICE and attach the images of your schematic and plots here. *Plot 3 curves on the same plot with 3 cycles each*.**   **Screenshot of schematic:**  **Screenshot of plot:** |
| 1. **Magnitude difference between *vS(t) and vC(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Volts***     **Phase difference between *vS(t) and vC(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Degrees*** |
| **Question 4 – RL Circuits – Pulse Source:**   1. **Create a simulation of your RL circuit and plots of (*vS(t), vR(t), and vL(t)*) in LTSPICE and attach the images of your schematic and plots here. *Plot 3 curves on the same plot with 3 cycles each*.**   **Screenshot of schematic:**  **Screenshot of plot:** |
| 1. **Magnitude difference between *vS(t) and vL(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Volts***     **Phase difference between *vS(t) and vL(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Degrees*** |
| **Question 5 – RMS Calculations:**  **Show your work!**   1. **RMS value of a 2Vpp sine wave:** 2. **RMS value of a 2Vpp square wave:** 3. **RMS value of a 2Vpp sawtooth wave:** |
| **Question 6 – Power Calculations:**  **Show your work!**   1. **Power of sine wave (V2/1K) averaged over time:**      1. **Power of square wave (V2/1K) averaged over time:** 2. **Power of sawtooth wave (V2/1K) averaged over time:**   **Comment on the relationship between the average power and the RMS value of the voltage**  **(Provide a formula):** |
| **Part 2 (10 pts): Hardware Lab Work** |
| **1) a) Multimeter reading of a 2Vpp sine wave: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_V**  **b) Multimeter reading of a 2Vpp square wave: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_V**  **c) Multimeter reading of a 2Vpp sawtooth wave: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_V**  **d) Based on your measurements, does the multimeter provide peak-to-peak voltages or RMS voltages?** |
| **2) Hardware RC circuit – Pulse Source**  **Build RC circuit on hardware and connect both channels of oscilloscope**  **Include a photo of your hardware circuit here (Have a look at an example photo at the end of this document):**  **Using your oscilloscope, plot *vS(t) and vC(t)*). *Make sure both waves are displayed on the same figure and the numbers are readable in the screenshot:***  **Screenshot of Oscilloscope Plot - Make sure that your computer’s date and time are showing up in your screenshot:** |
| **3) Hardware – RC Circuit – Sine Wave:**  **Change the voltage source (waveform W1 on your Analog Discovery kit) to a sine wave with the parameters as indicated in the manual.**  **Using your oscilloscope, plot *vS(t) and vC(t)*). *Make sure both waves are displayed on the same figure and the numbers are readable in the screenshot:***  **Screenshot of Oscilloscope Plot - Make sure that your computer’s date and time are showing up in your screenshot:**  **Provide the following from the oscilloscope plot of your RC circuit:**  **a) The magnitude of the voltage across the capacitor: \_\_\_\_\_\_\_\_\_\_\_V**  **b) The RMS of the voltage from the source: \_\_\_\_\_\_\_\_\_\_\_V**  **c) The phase difference, in degrees, between the source and cap voltage: \_\_\_\_\_\_\_\_\_\_\_Degrees**  **d) The capacitor voltage is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the source voltage**  leading or lagging |
| **4) Hardware - RL Circuit – Sine Wave:**  **Include a photo of your hardware circuit here (Have a look at an example photo at the end of this document):**  **Using your oscilloscope, plot *vS(t) and vL(t)*). *Make sure both waves are displayed on the same figure and the numbers are readable in the screenshot:***  **Screenshot of Oscilloscope Plot - Make sure that your computer’s date and time are showing up in your screenshot:**  **Provide the following from the oscilloscope plot of your RL circuit:**  **a) The magnitude of the voltage across the inductor: \_\_\_\_\_\_\_\_\_\_\_V**  **b) The RMS of the voltage from the source: \_\_\_\_\_\_\_\_\_\_\_V**  **c) The phase difference, in degrees, between the source and inductor voltage: \_\_\_\_\_\_\_\_\_\_\_Degrees**  **d) The inductor voltage is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the source voltage**  leading or lagging |
| **Part 3: Extra Credit (10 pts) - Bode Plots** |
| **Create bode plots of the shown RC circuit (*magnitude in dB, phase in degrees)* and attach an image of your plot here. *Make sure the numbers are readable in the photo.* You can depend on LTSpice as explained in the manual above or use the Analog Discovery 2 kit as explained in the following video** <https://youtu.be/31tq_A_2TcY>. Circuit connections are explained at min 4:16)  Bode plot (including magnitude and phase plots):  **Screenshot of Oscilloscope Plot - Make sure that your computer’s date and time are showing up in your screenshot:** |
| **LTSpice Screenshot Example (Note your name, date and time, readable circuit, and labelled nodes – screenshots might vary based on the operating system you are using) – This applies to screenshots of circuits only. Screenshots of graphs/plots/anything else can include only the date and time.**    **Hardware Image Example. Note your name:**   1. **on a piece of paper; OR** 2. **typed electronically (must be typed on the breadboard WITHOUT any “text background”. Breadboard must show up in the background of your name.)** |