Week 4: Experiment 24

Using Nodal or Mesh Analysis to Solve AC Circuits with an addition of Equivalent Impedance
Lab Lectures

• You have two weeks to complete Experiment 27: Complex Power
  • 10/3/2011 (Pre-Lab and Validation) and 10/7/2011 (Post-Validation Report)

• If you decide to make-up a lab for Weeks 2-4, it is due on 9/26/2011 (Pre-Lab and Validation) and 9/30/2011 (Post-Validation Report)
  • Use the generic assignment labeled Make-up 1 to upload the pre-lab and the post-validation report. The pre-lab should cover the information requested in the Analysis and Modeling sections of the lab on capacitor multipliers.
Experiment 24

• For the first part of Experiment 24, follow the instructions in the lab manual using the modified circuit shown in the next slide.

• Summary of Modifications
  • Frequency of operation: 20 kHz
  • Amplitude of voltage supply: 5V
  • Inductor: 1 mH
  • Capacitor: 2.2 nF
  • R1: 2 kΩ
  • R3: 2 kΩ
  • Your selected values for R2 and R4 (shunt resistors)
  • Reference all phase measurements to the phase of the voltage supply.
Modified Circuit
New Instructions: Equivalent Impedance

• Analysis
  – Calculate the equivalent impedance for the load at the frequency of operation (f = 20 kHz).

• Modeling
  – Use PSpice to show that the amplitude and phase of the voltage and current entering the load is the same as the voltage at V1 and current $i_1$ at f = 20 kHz.

• Measurement
  – Measure $i_1$ of the Equivalent Impedance Circuit and compare with the results obtained from the modified circuit of original experiment.
  – Provide an explanation for any discrepancies in phase or magnitude of the currents and voltages from the values obtained from your Analysis and that measured on the modified circuit of the original experiment.
Req and Ceq may need to be a combination of components to obtain the correct real and imaginary components of the equivalent impedance.
Measurements

• Measure the voltage at V1 of the first circuit and V1 of the equivalent circuit.
  – Demonstrate that the amplitude and phase angles are the same within experimental error.

• Measure $i_2$ and $i_3$ of the first circuit and $i_1$ of the equivalent circuit.
  – Demonstrate that the sum of the $i_2$ and $i_3$ of the first circuit equal to $i_1$ of the equivalent circuit within experimental error.
Velleman Oscilloscope

• If your values for R2 and R4, the shunt resistors, are the same, you can use one of the Math functions to sum \(i_2\) and \(i_3\).
Exporting Data To Excel
Scaling Required: Time

To determine the time to print on the x-axis:

Look at TIME STEP: for the number of points (125) that are equal to a time increment (1ms).

This means that the time for each point in the column under N should be divided by 125 and then multiplied by 1ms to determine the time at which each voltage data point was taken.
Scaling Required: 0V

To determine the value of the data point for Channel 1 and Channel 2 that is equal to 0V:

Look at the numbers above CH1 and CH2 on the GND row. The data point with value 177 is 0V for Channel 1 and with a value of 97 for Channel 2.

This means that 177 should be subtracted from each point in the column under CH1 and 97 should be subtracted from each point in the column under CH2.
To determine the voltage associated with each data point for Channel 1 and Channel 2:

Look at the numbers next to CH1: and CH2: above the GND row. In this case, 1V is equivalent to 32.

This means that the value of the points in the columns CH1 and CH2 should be divided by 32 and then multiplied by 1V to finally obtain the voltage measured by the oscilloscope on Channels 1 and 2 as a function of time.
Equivalent Circuit Current, $i_1$

- Suggestion – when measuring $i_1$, use a shunt resistor in the circuit with the same equivalent impedance as the shunt resistors in the original circuit so that you can directly compare the voltage measurements.
PSpice

• Did you know that you can easily switch between several types of simulations by adding the appropriate sources in your schematic and in your simulation profile?
  – For example: If you include a V_{sin} and a V_{ac} in your circuit, you can chose to simulate either the AC or Transient response when you run the simulation.
    • Note: The additional sources must follow the convention that would be appropriate if you used superposition.
      – I.e., voltage sources must be in series; current sources must be in parallel.
Select Type of Analysis

[Image: Simulation Settings - Experiment24 dialog box]

- **Analysis type:**
  - AC Sweep/Noise
  - Time Domain (Transient)
  - DC Sweep

- **AC Sweep Type**
  - Linear
  - Logarithmic

- **Noise Analysis**
  - Enabled

- **Output File Options**
  - Include detailed bias point information for nonlinear controlled sources and semiconductors (.OP)