Lab Final

Name: Solutions

lab notebook and calculator (50 min.)

I have neither given nor received unauthorized assistance during this test.

(signature)

(20 total) Using good laboratory practice and format, write up the following project as given in the procedure below; use the engineering paper as you would your notebook. Use the equipment on your workbench and the decade resistance and decade capacitance box; leads also are provided. The circuit that you will construct is shown below. Your objective is to measure the output sinusoidal steady-state voltage VR of the circuit at a number of given frequencies and to compare the simulated output phasors with the measured values of the phasors. Note: laboratory notebook format and presentation (4).

a. (2) Write a PSpice program to simulate the response of the circuit. Use AC analysis with VS = 1V amplitude over a frequency range from 100 Hz to 10 KHz. Use a PROBE analysis to display the magnitude and phase of VS and VR in the same window with one plot for magnitude and the other for phase. Note that since VS = 1V amplitude with 0 degrees phase that the plots for VR are the same as the magnitude and phase plots of the transfer function (ratio of the phasors at each frequency): VR / VS = VR / 1 = VR. Print the output file for your PSpice program -- remember that it can be accessed from the View menu.

b. (6) Build the circuit and use the function generator for VS: use a sinusoid with 2 Vpp and 0 V DC offset. Note that you will use VS as your reference voltage and measure VR as the output voltage. Keeping the amplitude of VS constant, measure the amplitude of VR and the phase of VR with respect to VS for the following frequencies: 200, 1000, 1500, 2000, and 10000 Hz. Use a table to record the data (don’t forget to include any necessary sample calculations).

c. (6) Annotate a printed PROBE output of the magnitude and phase of VR with the measured values of the magnitude and the phase of VR at the given frequencies. Use the cursors in PROBE to determine the magnitude and phase of VR at a frequency of 1000 Hz and calculate the percent error using the measured values as the reference. Discuss the reasons for any errors in the simulated values for the magnitude and the phase.

(2) For your conclusion, write a thoughtful, reflective paragraph on the results of your midterm exam project, and indicate your confidence in your work on this exam.
Lab partner: none

Objective: To measure the output sinusoidal steady-state voltage $V_a$ on the circuit below at frequencies between 200 and 10000 Hz and to compare those simulated output phasors with measured values of the phasors.

Equipment:
- Function Generator (FG): Agilent 33220A
- Oscilloscope (Scope): Agilent 54622A
- Multimeter (DMM): Agilent 34401A
- 1-10kΩ decade box
- 0.01-1.0µF decade capacitor box

Procedure:

a) $\text{Rs} = 0.1 \mu F$

$\text{Vs} = V_0 @ 2 \text{Vpp}, \text{OVD C}$

r = 1 kΩ set by decade box

Use PSpice simulation to present magnitude and phase of $V_s$ and $V_a$ between 100 and 10000 Hz using AC analysis. See output file and probe hierarchy attached. Amplitude of $V_s$ is 1 V (corresponds to 2 Vpp).

b) Measure $V_s(\omega)$ and $V_a(\omega)$ with oscilloscope - see circuit. Use quick measurement softkeys to get Vpp and phase 1 $\rightarrow$ 2 for $V_a$ with respect to $V_s$.

<table>
<thead>
<tr>
<th>Freq (Hz)</th>
<th>$V_a$(Vpp)</th>
<th>$V_a$(V)</th>
<th>$\theta_a$(deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>0.260</td>
<td>0.130</td>
<td>82.6</td>
</tr>
<tr>
<td>1000</td>
<td>1.070</td>
<td>0.535</td>
<td>57.7</td>
</tr>
<tr>
<td>1500</td>
<td>1.374</td>
<td>0.687</td>
<td>46.6</td>
</tr>
<tr>
<td>2000</td>
<td>1.564</td>
<td>0.782</td>
<td>38.5</td>
</tr>
<tr>
<td>10000</td>
<td>1.974</td>
<td>0.932</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Calculations: $|V_a|_1 = \sqrt{V_a^2} = 0.260^2 = 0.130$

C) From Probe display attached with cursors at $f = 10000 \text{Hz}$:

$|V_a| = 0.532 \text{ V} \quad \text{and} \quad \theta_a = 57.958 \text{ deg}$

Also, measured values for $|V_a|_1$ and $\theta_a$ are presented on PSpice output:

magnitude error: $\frac{|V_a|_{\text{Sim}} - |V_a|_{\text{Meas}}}{|V_a|_{\text{Meas}}} \times 100 = \frac{0.532 - 0.535}{0.535} \times 100 = -0.56\%$

phase error: $\frac{\theta_a_{\text{Sim}} - \theta_a_{\text{Meas}}}{\theta_a_{\text{Meas}}} \times 100 = \frac{57.958 - 57.7}{57.7} \times 100 = 0.27\%$

These errors are very small and could be attributed to the accuracy of the R and C settings on the decade boxes, as well as the accuracy of the oscilloscope.

Conclusions: The percent error difference between the simulated values and the measured values of $|V_a|$ and $\theta_a$ are less than 1%. Thus, there is close agreement. Therefore, there is high confidence that the procedure has been performed correctly.
**CIRCUIT DESCRIPTION**

**SIGNAL BIAS SOLUTION**

**NODE VOLTAGE**

<table>
<thead>
<tr>
<th>NODE</th>
<th>VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0000</td>
</tr>
<tr>
<td>2</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**VOLTAGE SOURCE CURRENTS**

<table>
<thead>
<tr>
<th>NAME</th>
<th>CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vs</td>
<td>0.000E+00</td>
</tr>
</tbody>
</table>

**TOTAL POWER DISSIPATION**

0.00E+00 WATTS

**JOB CONCLUDED**

TOTAL JOB TIME

0.85