Exam #3
ECE 320: Fundamentals of Electrical Engineering

Fall 2011

All Students:

- Exam is 50 minutes.
- Exam is closed book and notes.
- Answer questions as the directions state.
- You must show your work to receive full credit.
- Provide answers in the boxes provided.
- Be sure to include units on your answers as appropriate.
- No materials or calculators may be shared.
- No cell phone may be visible for any reason.
- Work only on the provided pages.
[1] (30 points)

Find the voltage and power supplied by the source for the circuit below. Also, find $V_A$, $I_1$, $I_2$.

\[ V_A = 254.3 \angle 10.3^\circ V \]

\[ V_s = 289 \angle 96.8^\circ V \]

\[ P_{Vs} = 106,554 < 36.6^\circ VA \]

\[ I_1 = 98.3 < -16.3^\circ A \]

\[ I_2 = 106.9 < -26.9^\circ A \]

\[ \cos (\Theta_v - \Theta_i) = 0.86 \]

\[ \cos^{-1}(0.86) = \Theta_i - \Theta_v \]

\[ \Theta_i = 30.7^\circ \text{ lagging} \]

\[ \Theta_v = 10.3^\circ - 36.6^\circ = -26.6^\circ \]
[2] (30 points)

Find the transfer function $\frac{V_{out}}{V_{in}}$ of the circuit below. Draw a Bode plot representation of the frequency response of the transfer function. (Do not forget to label magnitudes and phases.) Tell what type of filter is shown here.

\[ \frac{1}{\frac{1}{0.25s} + \frac{1}{1}} = R_{eq11} \]
\[ \frac{s}{s+3} = R_{eq11} \]

\[ V_{out} = \left( \frac{3}{3 + \frac{s}{s+3}} \right) V_{in} = V_{out} \]

\[ \frac{V_{out}}{V_{in}} = \frac{3}{3s + 12 + s^2} = \frac{3}{4s + 12} \]

\[ \frac{4s + 12}{s + 3} \]

\[ \frac{3}{s^2 + 3} \]

\[ \text{Transfer function: } \frac{75s + 3}{s + 3} \]

\[ \text{zeros: } -1 \]
\[ \text{poles: } -3 \]

\[ \omega_c = 3,4 \]

T.F. = \frac{75s + 3}{s + 3}
[3] (20 points)

Solve for the circuit below. Find $V_A$, $V_B$, $I$, and $V_O$.

\[ V_A = \frac{3 \cdot 5}{3 + 1 \cdot 5} (8V) = V_A = 6V = V_I = V_L = V_B \]

\[ I + 0 = I \]
\[ I = I = \frac{6V - 0V}{3 \cdot 5} = I = 2A \]

\[ V_O - 6V = 2A \]
\[ V_O - 6V = 4V \]
\[ V_O = 10V \]

<table>
<thead>
<tr>
<th>$V_A$</th>
<th>6 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_B$</td>
<td>6 V</td>
</tr>
<tr>
<td>$V_O$</td>
<td>10 V</td>
</tr>
<tr>
<td>$I$</td>
<td>2 A</td>
</tr>
</tbody>
</table>
[4] (20 points)

For each of the equations below, design a multi-stage amplifier circuit. Use whole number values for resistors. For the differential circuit, do not forget to pick the time constants.

A. \[ V_{out} = -4V_{in1} + 5V_{in2} \]

B. \[ 2y'' - 6y' - y = f(t) \]

\[ \begin{align*}
A) & \quad V_{out} = -\frac{R_2}{R_1} V_{in} \\
& \quad -4 = -\frac{R_2}{R_{11}} + 5 = -\frac{R_2}{R_{1a}} \\
\begin{bmatrix}
R_2 = 1 \\
R_{11} = V/4 \\
R_{1a} = V/5 \text{ \# inverter}
\end{bmatrix}
\end{align*} \]

\[ \begin{align*}
R_2 = 20 \Omega \\
R_{11} = 5 \Omega \\
R_{1a} = 4 \Omega \text{ \# inverter}
\end{align*} \]

\[ R_2C = 1 \]

\[ \begin{align*}
B) & \quad x = -\frac{1}{R_{1b}C_1} x + \frac{1}{R_{1a}C_1} x - \frac{1}{R_{11}C_1} f(t) \\
\end{align*} \]

\[ \begin{align*}
dy'' = 6y' + y + f(t) \\
y'' = 3y' + V_2 y + V_3 f(t) \\
x : \quad \frac{1}{3} = -\frac{1}{R_{1b}C_1}, \quad R_{1b}C_1 = \frac{1}{3} \text{ \# inverter} \\
x : \quad \frac{1}{3} = \frac{1}{R_{1a}C_1}, \quad R_{1a}C_1 = 3 \\
x : \quad \frac{1}{3} = \frac{1}{R_{11}C_1}, \quad R_{11}C_1 = 3 \text{ \# inverter} \\
x : \quad \frac{1}{3} = \frac{1}{R_2C_2}, \quad R_2C_2 = 1
\end{align*} \]