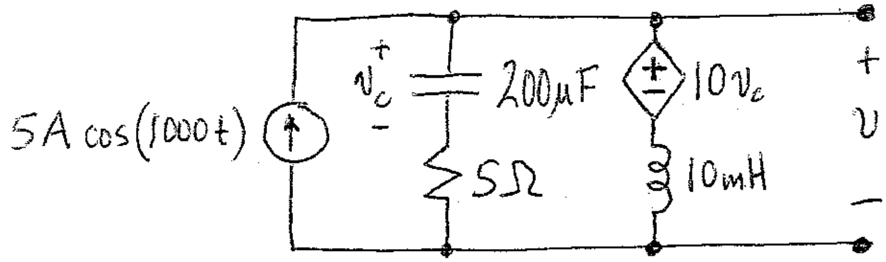
Name ______________________ UW ID#: ______________ Section: ___ Version A

Final Exam — EE 233

Spring 2002

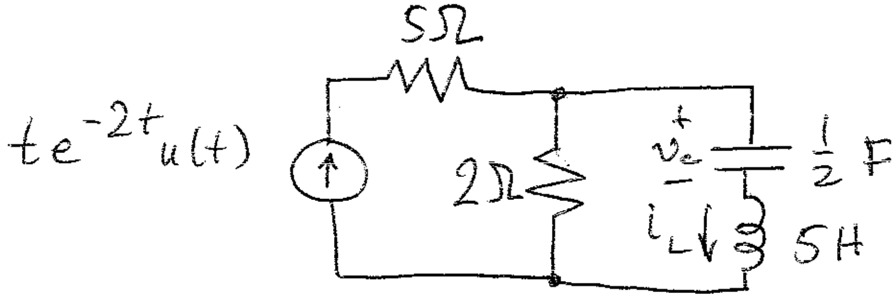
The test is closed book, with two sheets of 8.5 by 11 inch notes and standard calculators allowed. Show all work. Be sure to state all assumptions made and **check** them when possible. The number of points per problem are indicated in parentheses. Total of 150 points in 6 problems on 6 pages. A table of Laplace transform pairs are attached as page 7.

1. Determine the Thevenin equivalent of the circuit shown to the right. (20)



2. In the circuit to the right, $v_C = 2\,\text{V}$ and $i_L = 0.2\,\text{A}$ at $t = 0^-$.

   Draw the s-domain circuit valid for $t > 0$ and determine $I_L(s)$. (25)



3. The output of a circuit in the s-domain is:

$$V(s) = \frac{10s}{(s+3)^2} + \frac{s^2}{(s^2+4s+5)}$$

Find $v(t)$. (25)

4. For the transfer function

$$H(s) = \frac{s(s+10^5)}{(s^2+2000s+10^8)}:$$

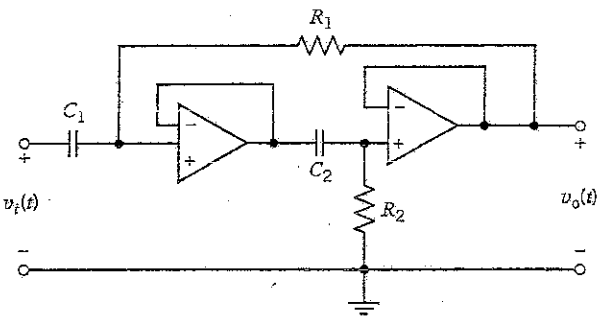
Sketch the *asymptotic* Bode plot (gain in dB and phase in degrees versus $\log_{10}\omega$). (25)

- On both plots, indicate the slopes of the asymptotic behavior within each frequency range.
- At the corner frequencies of the amplitude, calculate the amplitude and phase for the asymptotic approximation.
- On the amplitude plot, also indicate the actual gain at each corner frequency.

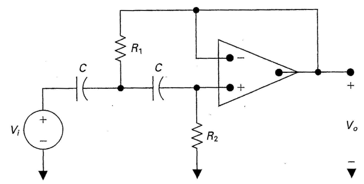
5. A filter is constructed using the circuit at the right.

   Find the transfer function $H(s)$ in terms of R_1, R_2, C_1, and C_2.

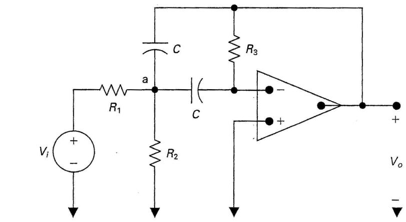
   What type of filter is it? (20)



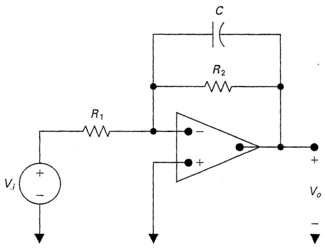
6. Given these filter circuits with associated transfer functions:



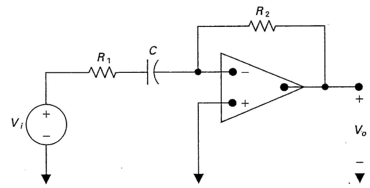
$$\frac{s^2}{s^2 + 2s/(R_2C) + 1/(R_1R_2C^2)}$$



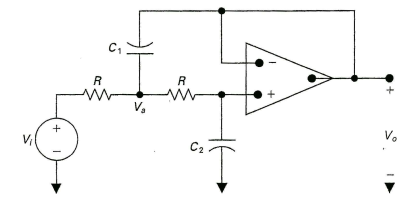
$$\frac{-s/(R_1C)}{s^2 + 2s/(R_3C) + (R_1 + R_2)/(R_1R_2R_3C^2)}$$



$$\frac{-1/(R_1C)}{s + 1/(R_2C)}$$



$$\frac{-sR_2/R_1}{s + 1/(R_1C)}$$



$$\frac{1/(R^2C_1C_2)}{s^2 + 2s/(RC_1) + 1/(R^2C_1C_2)}$$

Using the above active filter blocks, design a Butterworth highpass filter with cutoff frequency of $\omega_c = 2000$ rad/s and a pass-band gain of magnitude 34dB. If the gain must be below 0dB for frequencies below 500 rad/s, what is the minimum filter order? Specify all component values, using 10nF capacitors whenever possible without increasing the part count. (30)

End Of Exam