EE 40 – Introduction to Microelectronic Circuits

Fall 2005, **Prof. A. R. Neureuther**
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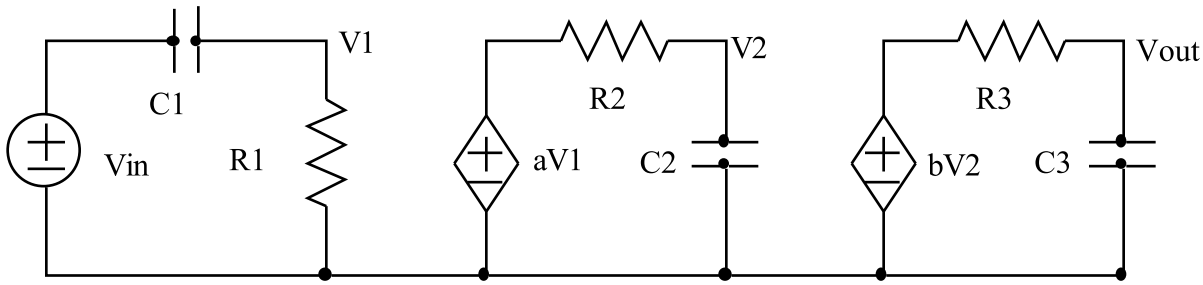
Problem Set # 9

Due: 5 PM Tuesday, Nov. 8th, 2005 in 240 Cory

9.1 Phasors, Transfer Functions and Frequency Response
Use the values C1 = 1uF, R1 = 100kΩ, C2 = 1uF, R2 = 100Ω, C3 = 1nF, R3 = 100Ω.
Use a = b = 100.
Given the following circuit, work through the following:

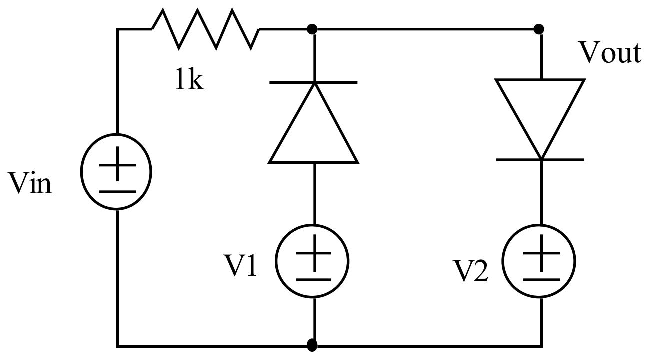


a) Derive a complex algebraic solution for Vout/Vin. Write this transfer function in fully factored form (both the numerator and the denominator should be written as a product of complex factors of the form either jwA or (1+jwB)).
b) On the calculator you will use at the exam, calculate the complex value Vout/Vin at a frequency of w = 10^5 rad/s. Write this in both A + jB and $Me^{j(phase)}$ form.
c) Find the limit as frequency goes to 0, and to infinity, of the magnitude and phase of the transfer function. Also, determine any break frequencies of zeros and poles of your transfer function.
d) Provide a magnitude Bode plot and a phase Bode plot of the transfer function. Be sure to choose your range on the frequency axis to capture all important behaviors of your transfer function.

9.2 Cascade Op-amps
Suppose you are designing a circuit that, given two inputs V1 and V2, is supposed to perform the following task: over each second, you want to take the time-varying difference V1 - V2 and make sure that the integral of this difference over each second of observation is not greater than 5V*s (assume the circuit you design simply reports the integral value to some greater control circuit).

You have at your disposal: ideal op-amps, resistors, capacitors. Assume you can use a switching discharge circuit(just use a switch symbol in your drawings) for any capacitors so that they automatically discharge completely at the end of every second. Construct your circuit.

9.3 Analyzing Diode Circuits
Suppose the following circuit. Assume R = 1kΩ, V1 = -2V, V2 = 3V. Assume you are using the ideal diode model.



a) For an input Vin = -3V, determine Vout and the current through the resistor (with direction).
b) For an input of Vin = 4V, determine Vout and the current through the resistor (with direction).
c) Given an input sinusoid Vin1 = 5cos(2πt), plot the output of the circuit over the interval from 0 to 5 seconds.
d) What does the circuit do?

9.4 Diode Logic Gates
Use the circuit from slide 20 of lecture 24 (Diodes in TTL). Use the large signal model for diodes, assume Vin goes into both the A and B terminals. Assume Vout is taken at terminal F. Let R1 = 5kΩ and R2 = 1kΩ, and use a value of β = 30.

a) Plot the input current I1 as identified in the circuit versus Vin.
b) Plot Vout versus Vin.
c) Assume the output of this circuit feeds the inputs of N identical gates. Find the maximum value of N where this circuit could still have an output Vout = 1V for some input.
d) Show how to add a diode and a voltage source to the output so that the output cannot go above 5V or below 0.2V.