EE 40 – Introduction to Microelectronic Circuits

Fall 2005, **Prof. A. R. Neureuther**
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Problem Set # 7

Due: 5 PM Tuesday, Oct. 25th, 2005 in 240 Cory

Reading: Hambley 3rd Ed. Sections 14.1-14.6

7.1 Op-AM Types

Use figure 14.33 in the text on page 665 (it has 4 resistors).

a) Convert R2 to a capacitor with capacitance C and derive the expression for V_{out} as a function of V_{in1} and V_{in2} for sinusoidal inputs.
b) For your circuit from a), add a resistor R5 from + to the output and derive the expression for V_{in} of the form $V_{in} = f(V_{in1}, V_{in2})$.
c) For your circuit in b), ground V_{in1}. What is the maximum input sinusoid magnitude V_{in2} for a plus and minus 5V power supply ($V_{hi} = 5V$, $V_{low} = -5V$) before railing occurs?
d) Go back to your circuit from part a) (Remove R5). Ground V_{in1}. Perform an analysis for a DC input V_{in2}. Find V_{out} in terms of V_{in2} and time, assume the capacitor initially is fully discharged at t = 0. What does this circuit do?

7.2 Cascade Op-Amp Analysis and Output Currents

Use figure 14.9 in the text on page 641. Use symbolic values for all resistors.

a) Discuss how and why the given circuit can be separated into two independent stages for analysis.
b) Find the currents at the input to each amplifier stage, and through the load (at the input means current through the node at the input terminal, not current into the input terminal).
c) Find the current provided by the op-amp output for each stage.
d) Find an expression for V_{out} in terms of the two inputs. What does this circuit do?

7.3 Building Op-Amps from Amplifiers

Assume that the contents of an op-amp are a two-port amplifier with infinite input impedance, a gain of 100,000 and a 10Ω Thevenin output impedance. Use figure 14.2 in the text on page 634, with a 10Ω resistor R_{out} in series with the dependent source on the + side. Assume input resistance is infinite.

a) Using the ideal op-amp framework, design an inverting amplifier. It should have a gain of –10, with the + terminal grounded. Give values for your components. Connect your components at the corresponding nodes in the non-ideal framework. When you work with the non-ideal model, how does your gain change? Find V_- and V_{out} when V_{in} = 0.4V. For an inverting amplifier, V_+ should be grounded.

b) Assume that A is frequency dependent 1/(1+f/100MHz)). Find the frequency at which the overall response drops by about 3 dB.