Midterm Examination

Electronic Circuits I - 304-330A
October 18th 2001, 10:05 AM – 11:25 AM
Professor David Plant

Pertinent Information:

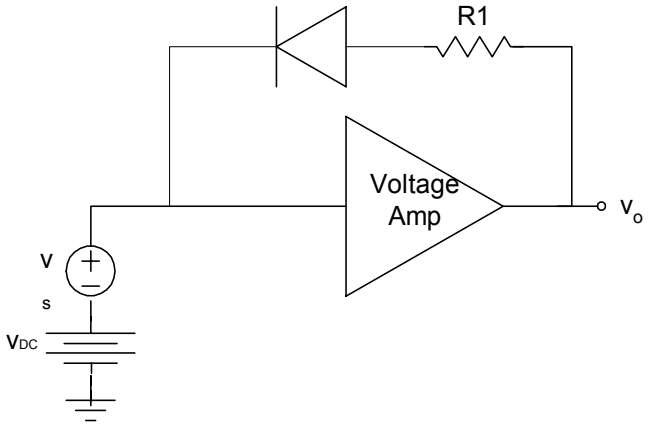
1) This is a closed-book examination, no notes permitted.

2) The examination consists of 4 problems; 37 total possible points.

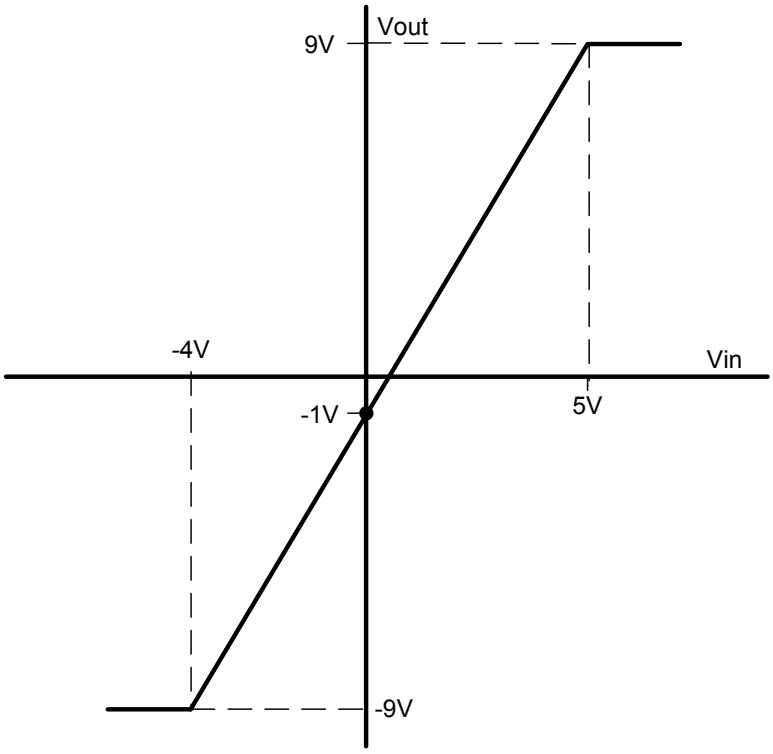
3) Only the Faculty Standard Calculator is permitted.

Question #1 [10 pts]:

Consider the following circuit. Ignore the output resistances of the amplifier and voltage sources. Assume n=1 for the diode.



The Voltage Amplifier in the above circuit has the following voltage transfer characteristic:



For parts (a) and (b) V_S is off and use the Constant Voltage Drop Model (CVDM) for the diode.

a) [2 pts] Find the values of V_{DC} for which the diode is *off*.
b) [2 pts] For $V_{DC} = 2.5$, find the value of R1 for which the current through the diode is 2mA.

For parts (c),(d) and (e), assume that the V_{DC} = 3.5V, V_S is a small signal source of the form $V_S=V_1 \sin\omega t$, R1= 2kΩ and the DC current through the diode is 0.9mA.

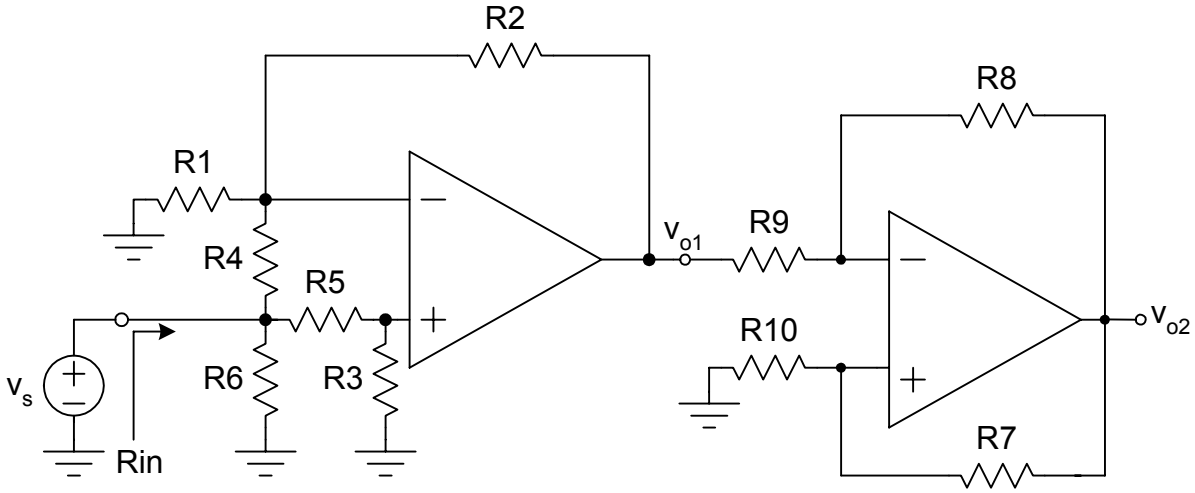
c) [2 pts] Draw the small signal equivalent circuit.
d) [2 pts] Write down the expression for the *total* current through the diode in terms of V_S.
e) [2 pts] Find the maximum value for V_1 for which the circuit operates with no clipping.

Question #2 [12 pts]:

Consider the following circuit. Assume that both op-amps have infinite gain.

Table 1
R1 = 50 Ω
R2 = 1 kΩ
R3 = 1 kΩ
R4 = 50 Ω
R5 = 99 kΩ
R6 = 1 kΩ
R7 = 1 kΩ
R8 = 100 kΩ
R9 = 1 kΩ
R10 = 1 kΩ

Stage 1 Stage 2



a) [3 pts] Calculate the voltage gain (v_{o1}/v_s) of the first stage using the resistor values of Table 1.

b) [1 pts] Find the expression (i.e. do not plug in resistor values) for the input resistance (Rin) of the first stage. Assume that R4 is ∞ for this part of the problem only.

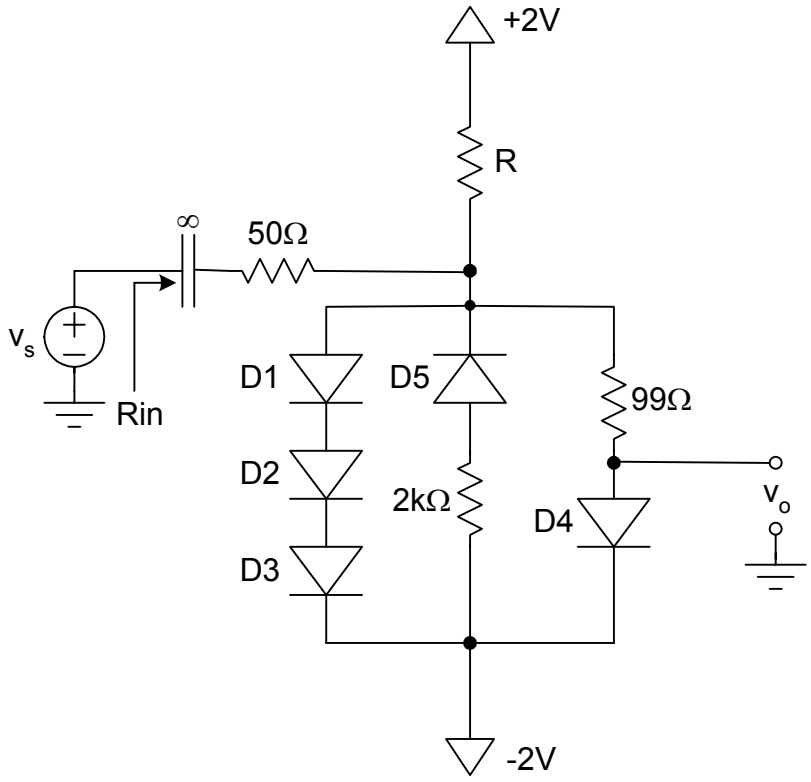
c) [3 pts] Calculate the voltage gain (v_{o2}/v_{o1}) of the second stage using the resistor values of Table 1.

d) [2 pts] Calculate the overall voltage gain: v_{o2}/v_s.

e) [3 pts] Replace R7 by an open-circuit and calculate the gain of the second stage v_{o2}/v_{o1}, assuming that A = 100.

Question #3 [10 pts]:

Consider the following circuit. Assume that all diodes are identical with n=2, and conduct 5 mA when forward biased at 0.7V.



a) [3 pts] Calculate R such that the DC output voltage, V_O, is –1.25V. Do NOT assume the Constant Voltage Drop model. Hint: all diodes but one are on.

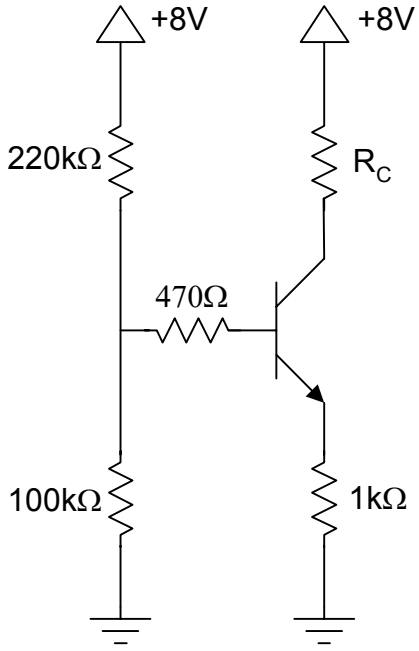
b) [3 pts] Draw the small-signal equivalent circuit diagram, and calculate the values of the small signal diode resistances.

c) [2 pts] Calculate the small-signal voltage gain v_o/v_s.

d) [2 pts] Calculate the small-signal input resistance seen by the source, v_s.

Question #4 [5 pts]:

Consider the following circuit.



a) [2 pts] Assume $\beta = \infty$, $V_A = \infty$, and $R_C = 4k\Omega$. Determine whether or not the BJT is in the active mode.

b) [3 pts] Assume $\beta = 100$, $V_A = \infty$, and $R_C = 3k\Omega$. Find the DC voltages and currents: V_C, V_B, V_E, I_C, I_E and I_B. Verify the BJT is in the active mode.