ELEN E1201
Spring 2003
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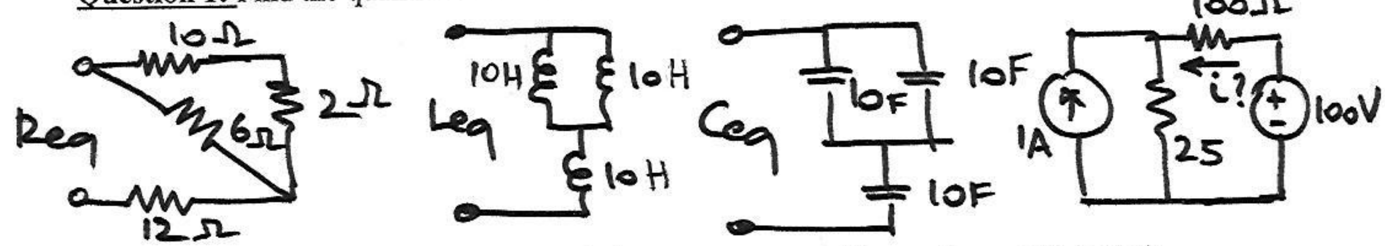
FINAL EXAM

3 hours – 7 Questions
closed book
no calculators

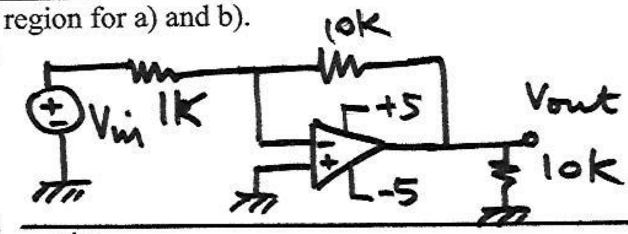
Please note: We cannot read your work carefully unless you write it carefully. Answers without a clear derivation will receive zero credit.

Question 1: Find the quantities indicated.



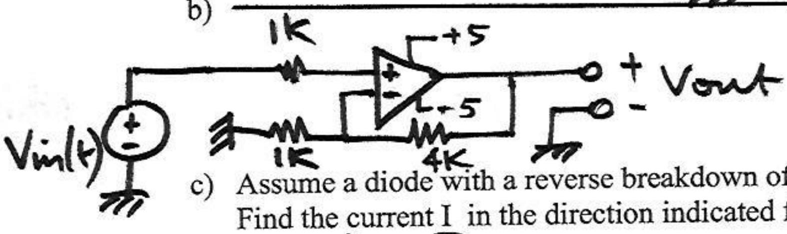
Question 2: Find the quantities indicated. Assume opamps with very large gain in their linear region for a) and b).

a)



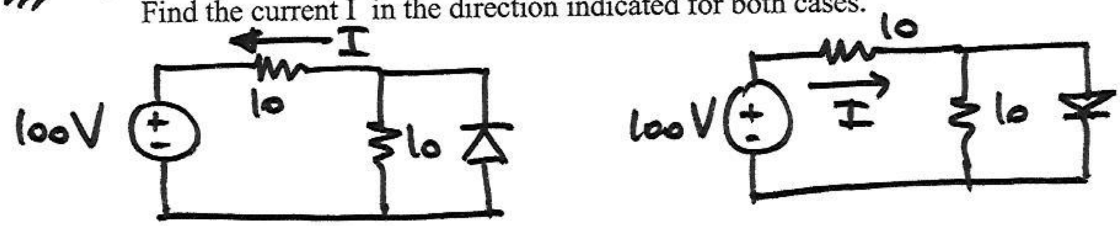
$V_{in} = 0V \rightarrow V_{out} = ?$
$V_{in} = 0.2V \rightarrow V_{out} = ?$
$V_{in} = -5V \rightarrow V_{out} = ?$

b)



$V_{in}(t) = 0.01 \sin(500t)$
$\rightarrow V_{out}(t) = \ldots\ldots$ ← expression

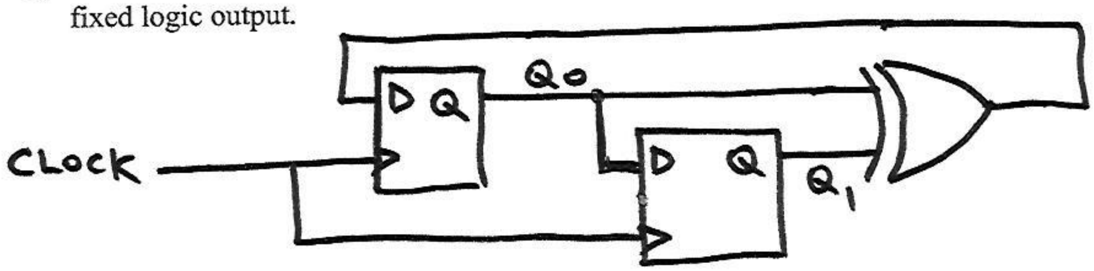
c) Assume a diode with a reverse breakdown of -10V and a forward voltage of 0.7V. Find the current I in the direction indicated for both cases.



Question 3:

a) Plot the logic signals Q0 and Q1 for the flip-flop circuit shown below. The flip flops are positive clock edge triggered D flip-flops. The initial state of Q0 is high and the initial state of Q1 is low.

b) Indicate if this circuit exhibits a repeating pattern at its output or settles into a fixed logic output.



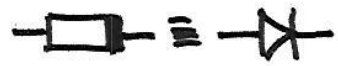
Question 4: You are hired by the Metropolitan Transit Authority to design a speed limiting device for their city buses. Safety studies have shown that the bus speed should be limited to 50miles/hour at all times. During the night however, a stricter speed limit of 30miles/hour needs to be observed. When it is raining, the daytime speed limit reduces to 30miles/hour and the night time limit to 20miles/hour.
Your device receives two logic inputs: input line N is high if it is nighttime; input line R is high if it is raining. Your device has three outputs: line F goes high when the speed limit is 50miles/hour; similarly lines TH and TW indicate speed limits of 30 and 20miles/hour respectively. At all times *only one* of the outputs can be logic high.

a) Make a truth table for the three output signals as a function of the two inputs.

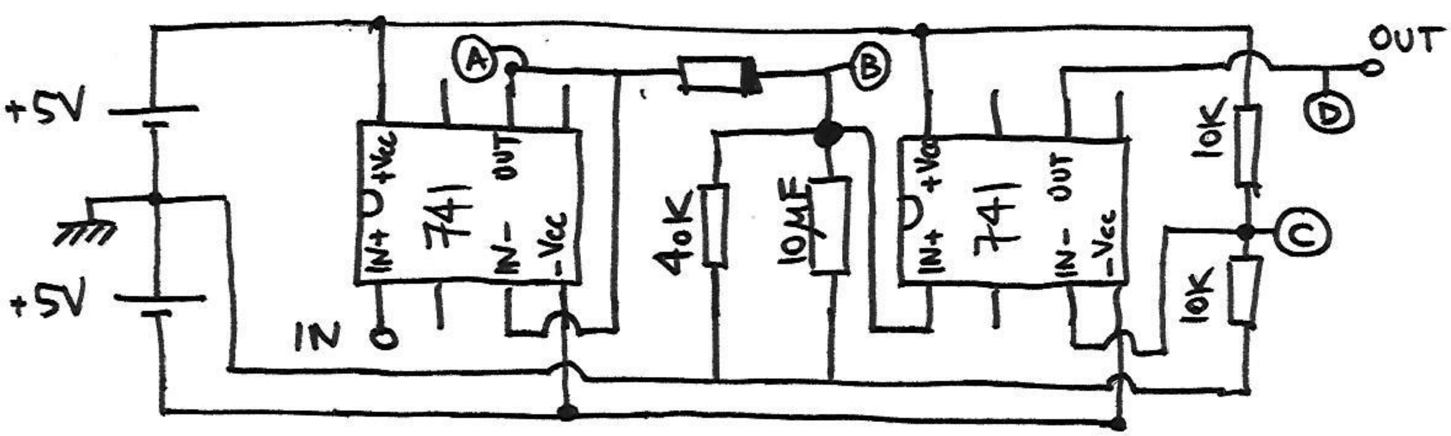
b) Write out the sum-of-products realization for each output. Verify if you can do any simplifications.

c) Make a logic circuit using 2 input NAND gates only. Try to use as few NAND gates as possible.

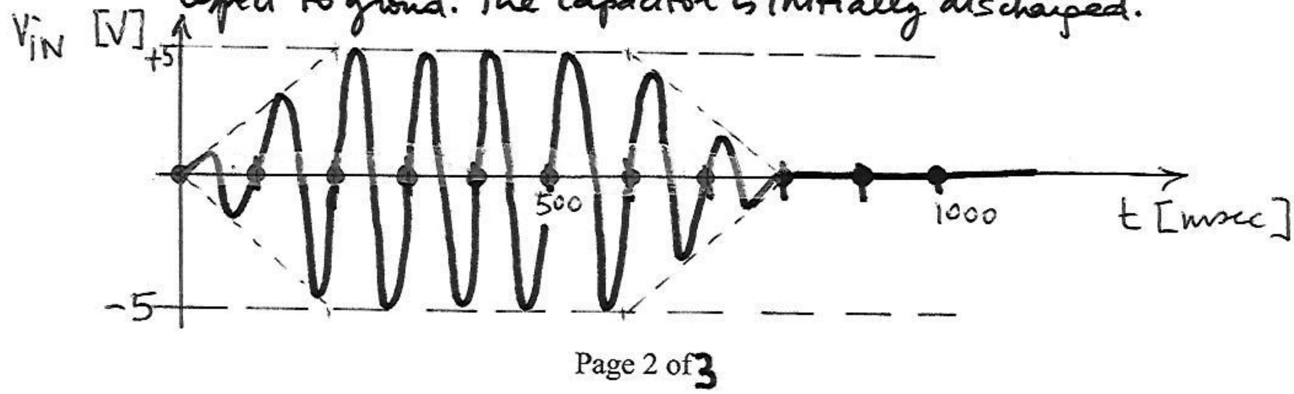
Question 5: You are shown the following circuit board.



a) Draw an equivalent circuit diagram using standard circuit symbols.



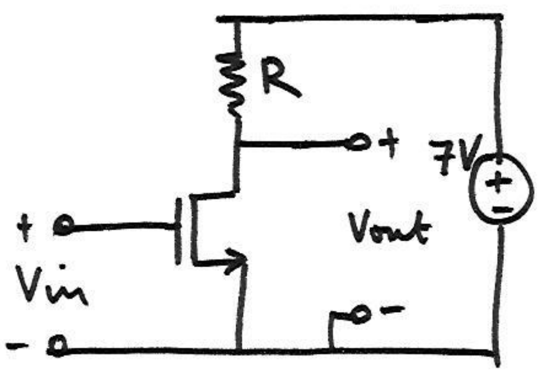
b) Assume the diode is ideal and the opamps have a very large gain in their linear region. You apply the following signal at the input of the circuit. Plot the waveforms at the points A, B, C, and D in the circuit for the shown input signal. with respect to ground. The capacitor is initially discharged.

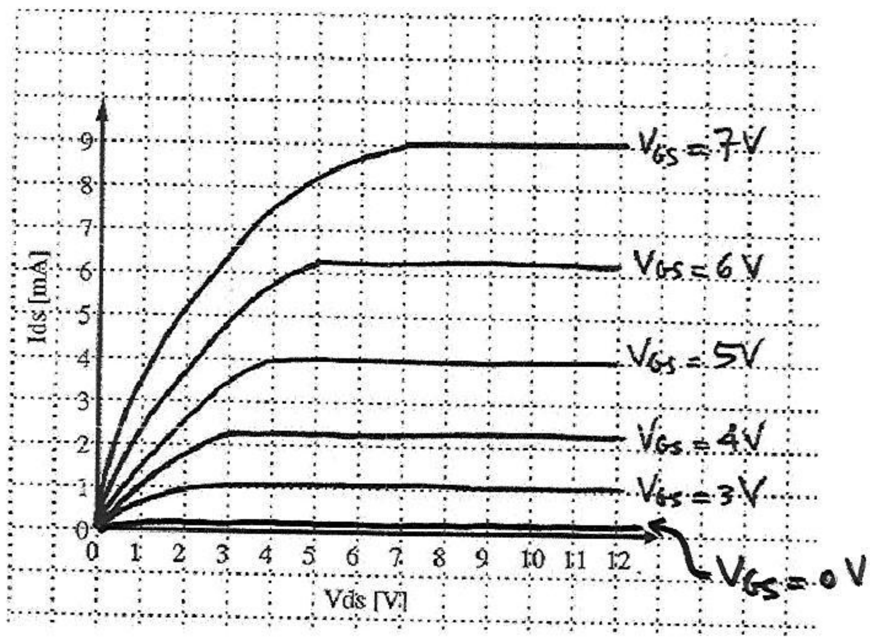


Question 6: You are asked to design a logic inverter using the circuit shown below with an nMOS transistor and a resistor. The transistor characteristics are given below.

a) Find the appropriate value of the resistance R so that Vout > 6.5V when Vin=0 and Vout < 2V when Vin=7V.

b) For your choice of R, plot Vout as a function of Vin, for Vin: 0→7V. If you are not able to solve part a), clearly indicate so, and use a resistance value of 2 K for this part.

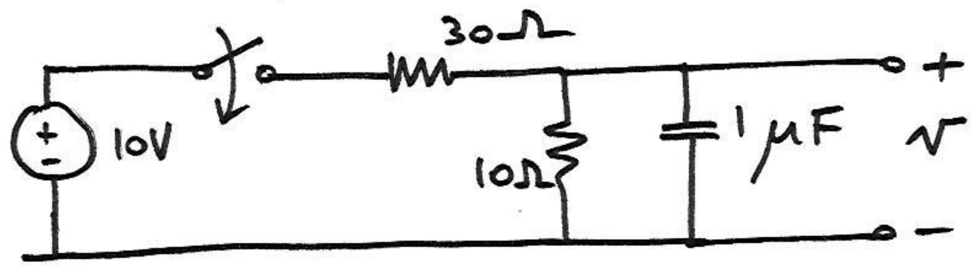




Question 7: The switch in the circuit below has been open for a very long time. At time t=10sec the switch closes.

a) Find the DC steady state voltage V when the switch is open
b) Find the DC steady state voltage V when the switch is closed
c) Find the expression for V(t) valid for t: 0 → +∞
d) Plot V(t) as a function of time. Indicate interesting points

Remark: Remember you can (but you do not have to) apply Thevenin/Norton source transformations if you feel this simplifies the problem. Or, if you prefer you can write out the differential equation for V.



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Good luck!