

ENGR-4300
Spring 2009
Test 3

Name _____

Section 1(MR 8:00) 2(TF 2:00) 3(MR 6:00)
(circle one)

Question I (20 points) _____

Question II (15 points) _____

Question III (20 points) _____

Question IV (20 points) _____

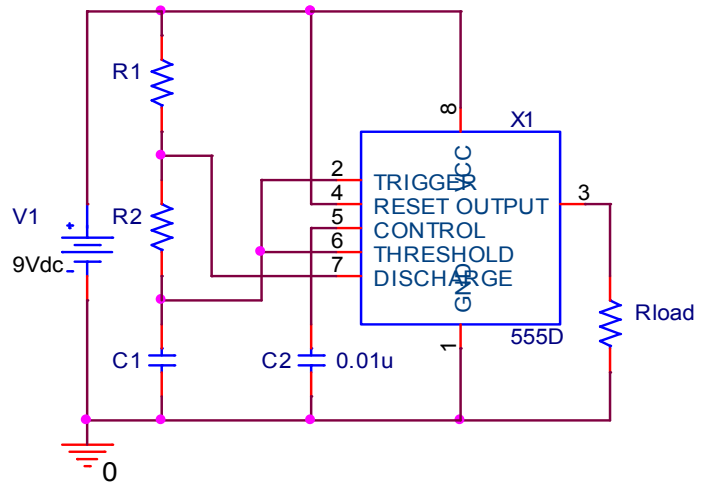
Question V (25 points) _____

Total (100 points): _____

On all questions: SHOW ALL WORK. BEGIN WITH FORMULAS, THEN SUBSTITUTE VALUES AND UNITS. No credit will be given for numbers that appear without justification.

Question I – Astable Multivibrator (20 points)

1. (4pt) The 555 timer circuit shown is to have a duty cycle of 60% (3/5). For a given C_1 , what ratio of resistors R_1/R_2 will produce this duty cycle



2. (4pt) Using a ratio of $R_1/R_2 = 3$ and with $C_1 = 30\mu\text{F}$, calculate the values for R_1 and R_2 needed to yield a frequency of 10Hz.

3. (2pt) For pin 2/6, what part of the *internal* circuit determines the thresholds to switch from charge to discharge?

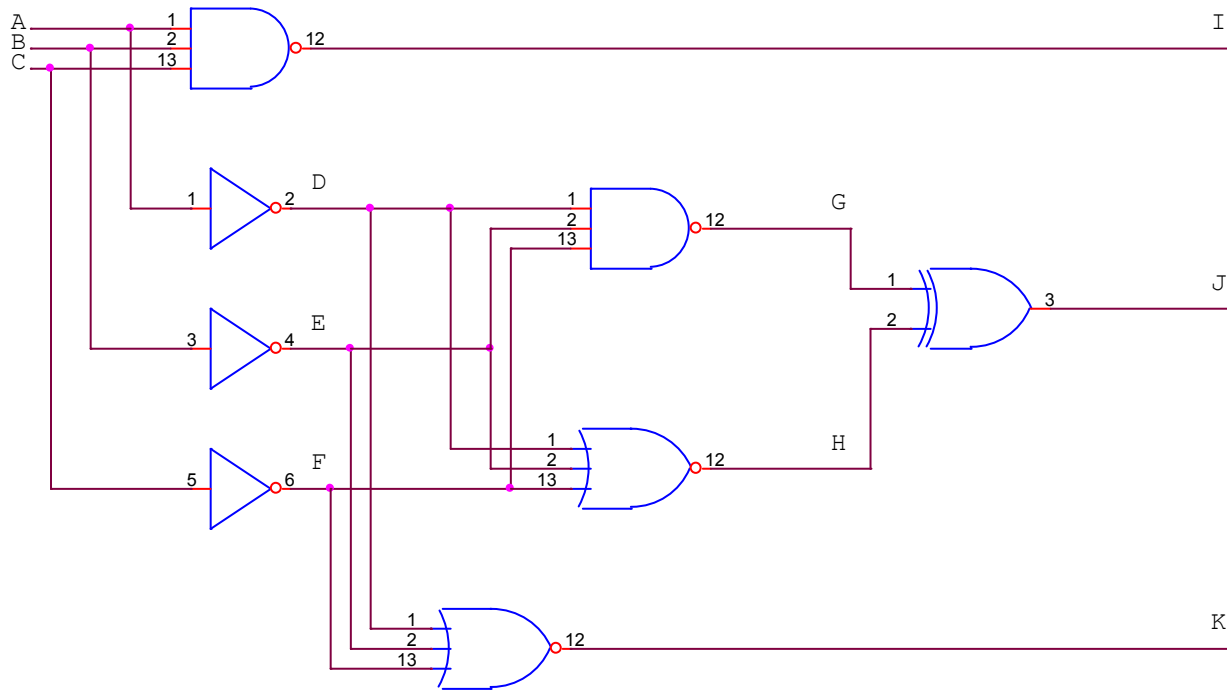
4. (2pt) For pin 7, what component in the *internal* circuit determines whether the capacitor charges or not *and* how? (the component most directly connected to pin 7)

Question I – Astable Multivibrator (continued)

5. (4pt) For an ideal 555, what are the maximum and minimum voltages on pin 2/6 above during normal operation?

6. (4pt) For an ideal 555, what are the maximum and minimum voltages on pin 7 above during normal operation? (note: use values of resistors from part 2)

Question II – Combinational Logic Circuits (15 points)



1. (8pt) Complete the table below for the circuit above (all or nothing, continuation of mistakes will be deducted)

A	B	C	D	E	F	G	H	I	J	K
0	0	0								
0	0	1								
0	1	0								
0	1	1								
1	0	0								
1	0	1								
1	1	0								
1	1	1								

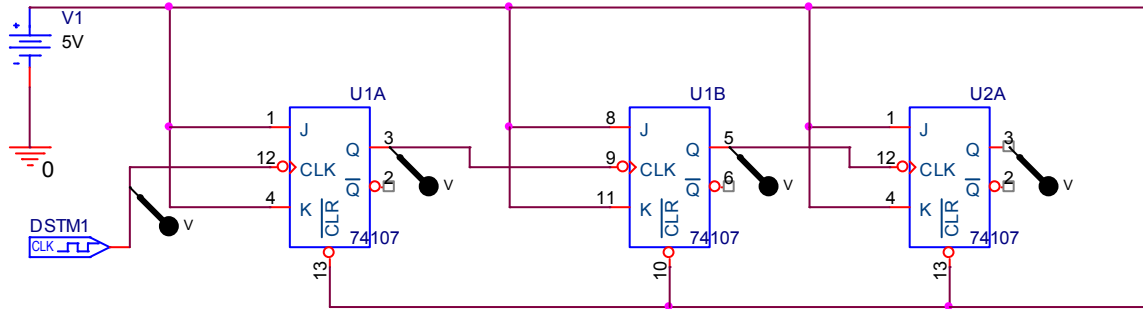
2. (2pt) Given the input values of A, B, and C, and the corresponding output of K, what logic gate would give the same output as the entire circuit above?

3. (5pt) Fill out the truth table below to prove the following relationship: use as many columns as needed

$$\text{If } Q = ((\overline{A} \bullet \overline{B}) + (A \bullet \overline{B})) + (\overline{A} \bullet B) \text{ then } Q = A \oplus B$$

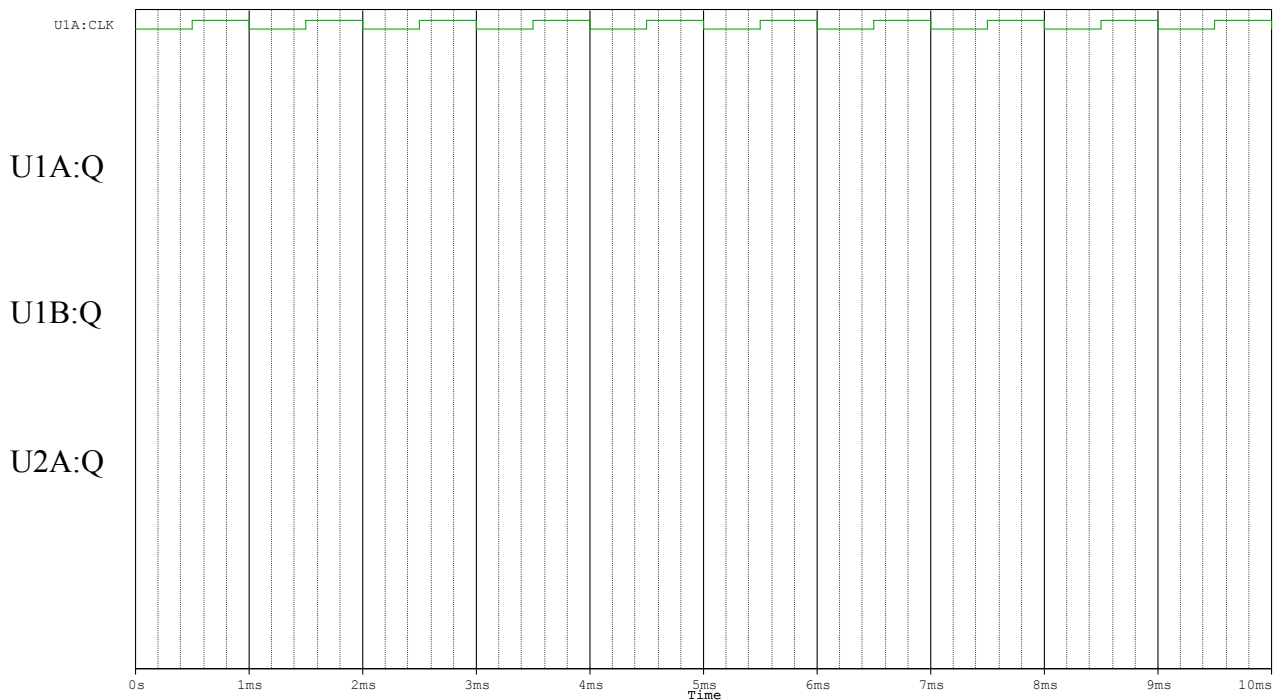
A	B									
0	0									
0	1									
1	0									
1	1									

Question III – Sequential Logic Circuits (20 points)



In the circuit pictured above, clock DSTM1 provides a clock signal to the first JK flip flop. This circuit follows the falling edge of the clock.

1 (6pt). The timing diagram below shows the clock DSTM1. Draw the rest of the timing diagram with probes at the Q output of U1A, U1B, and U2A. Assume all the Q outputs start low.

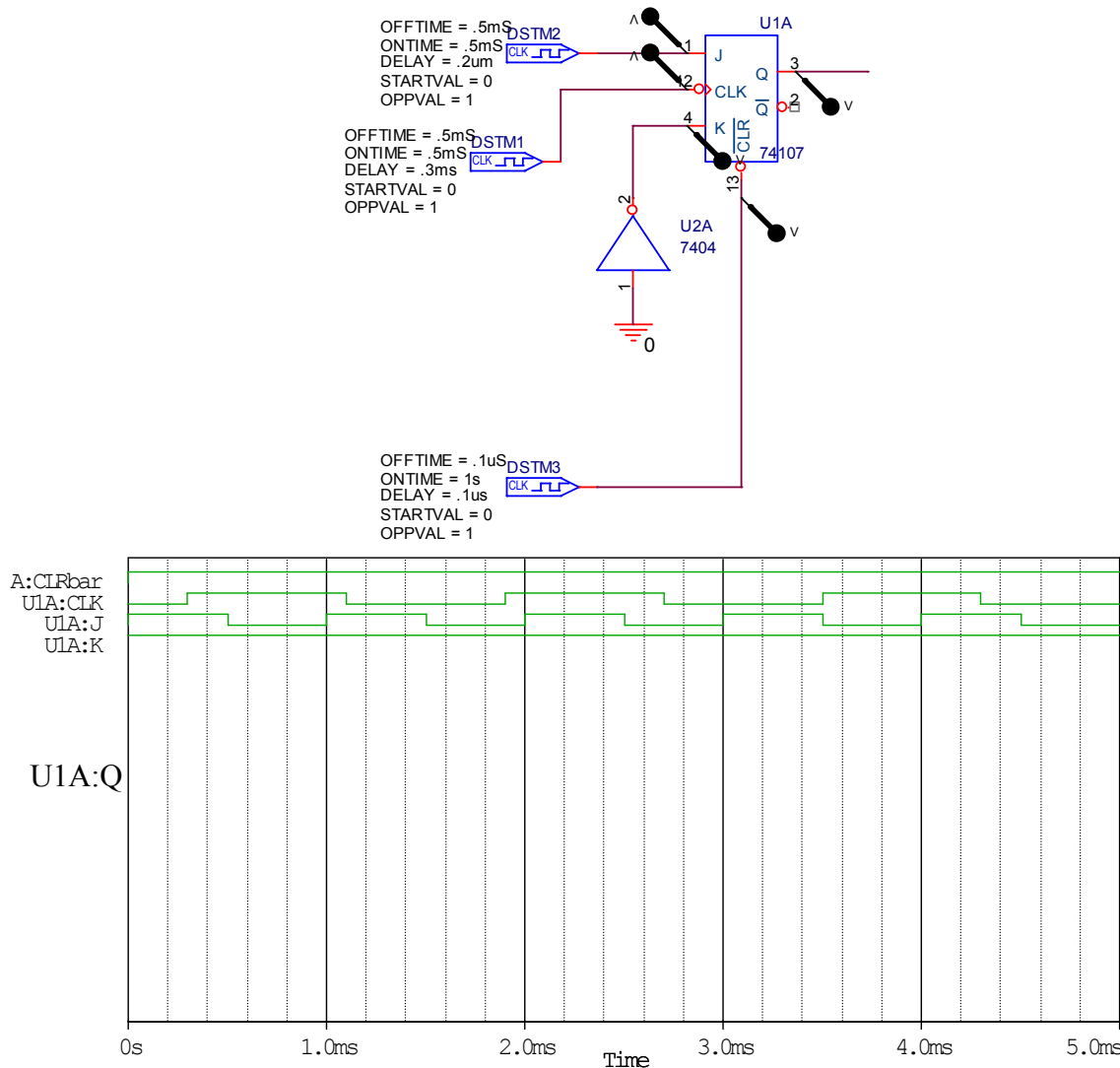


Question III – Sequential Logic Circuits (continued)

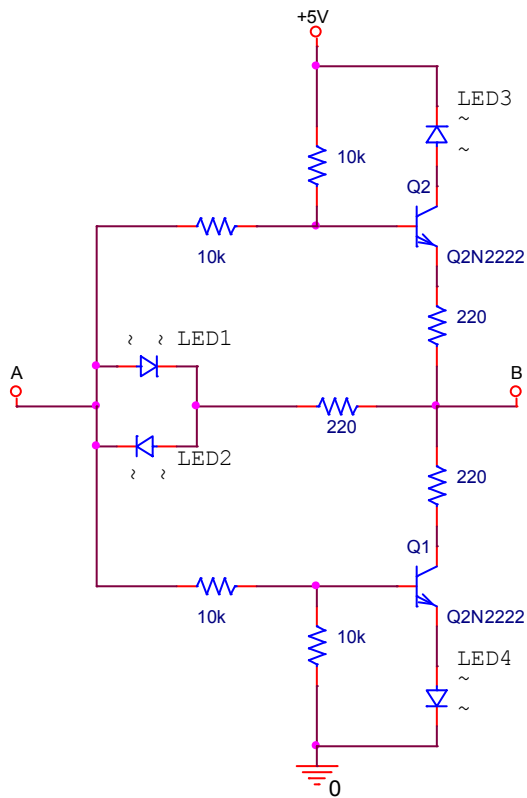
2. (4pt) If this is a 3-bit counter, write the 3-bit binary number *and* decimal value at 9.5 ms.

3.(4pt) What binary number and decimal value would occur after 18 negative clock pulses?

4. (6pt) The following is a diagram of one flip flop. Remember that flip flops trigger on the falling edge of the clock pulse. The timing diagram demonstrates the J, K, and clock pulses given. Determine the output Q and write it on the timing diagram. Q starts out low.



Question IV – Switching Circuits (20 points)



In the circuit above, the voltages applied to points A and B are either 0V or 5V. The 2N222 transistors will act as switches that are either on or off. Assume the LEDs will turn on safely with a forward current between 15 and 30mA.

1. a) (2pt) For A equal to 0V, what are the voltages at the base of Q1 and Q2?

b) (2pt) For A equal to 5V, what are the voltages at the base of Q1 and Q2?

Question IV – Switching Circuits (continued)

2. (8pt) For the given voltages on A and B, fill in the chart below with the states of Q1 and Q2 (ON or OFF).

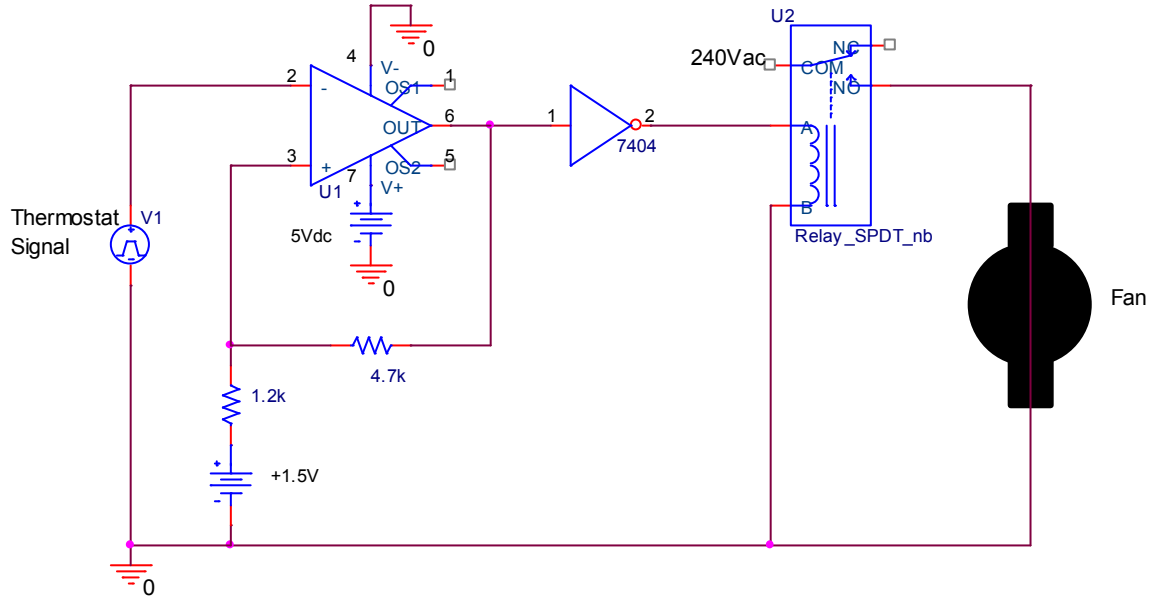
A voltage	B voltage	Q1	Q2
0V	0V		
0V	5V		
5V	0V		
5V	5V		

3. (8pt) For the given voltages on A and B, fill in the chart below with the states of the 4 LEDS (ON or OFF).

A voltage	B voltage	LED1	LED2	LED3	LED4
0V	0V				
0V	5V				
5V	0V				
5V	5V				

Question V – Comparators and Schmitt Triggers (25 points)

A noisy thermostat voltage signal is used to activate a cooling fan. To prevent a premature burnout of the fan’s control relay from constant on-off switching, a Schmitt trigger is employed. Assume the op-amp in the circuit is ideal.

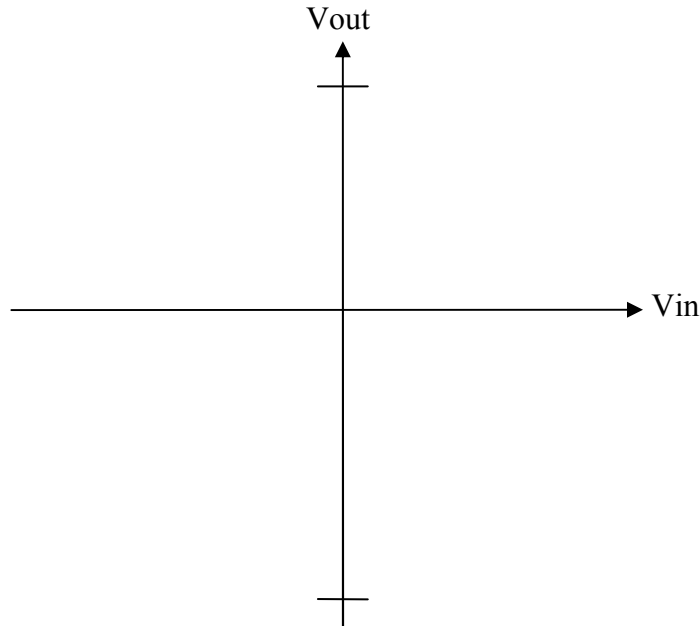


1. (6pt) For the above circuit, find the two Schmitt trigger switching voltages.

2. (3pt) Why is the inverter necessary in the circuit?

Question V – Comparators and Schmitt Triggers (continued)

3. (5pt) On the axes below sketch the input-output hysteresis curve for a Schmitt trigger similar to that in 1. Be sure to scale both axes. *Assume the switching voltages are 1.5V and 3.5V for this plot.*



4. (4pt) Is it possible to implement the same functionality without the inverter, but still using only the components in the circuit above? If so, explain how.

5. (3pt) TRUE or FALSE: In general, it is possible to keep the width of the hysteresis band unchanged but move both switching points up or down by changing only V_{ref} , the reference voltage.

6. (4pt) It is desired that the lower switching threshold on the original circuit be dropped to 0V by changing the op-amp's negative supply voltage. What should the new negative supply voltage be?