

ENGR-4300

Electronic Instrumentation

Quiz 3

Fall 2011

Name _____

Section ____

Question I (20 points) _____

Question II (20 points) _____

Question III (20 points) _____

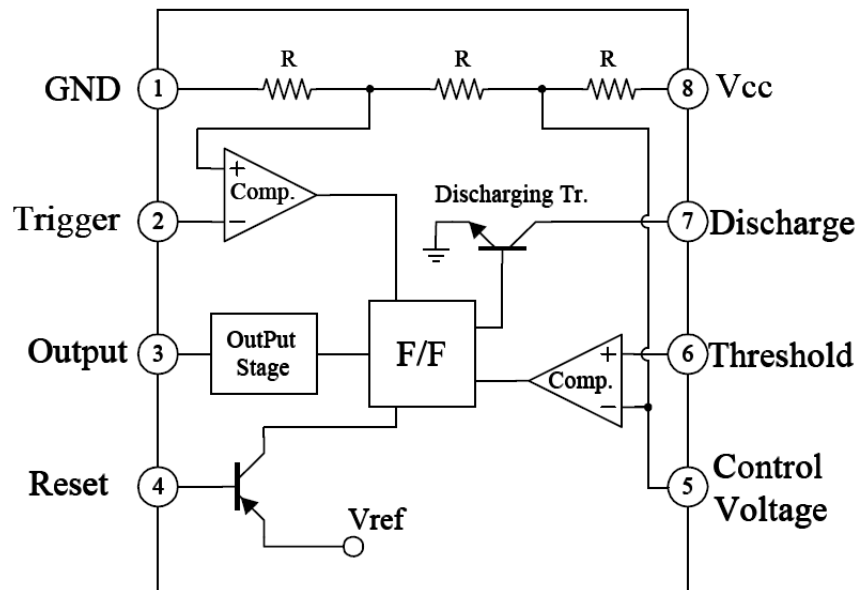
Question IV (20 points) _____

Question V (20 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.

Some Additional Background



The First Native American Engineer

The American Indian Science and Engineering Society (AISES) recognizes Ely S. Parker as the first Native American engineer. Each year at its national conference AISES presents its highest honor, the Ely S. Parker Award, to recognize those American Indian individuals who have made significant long-term contributions in the Sciences, Mathematics, Engineering, Technology, Health or related fields; and who have served the American Indian Community in an exemplary manner.

From Wikipedia: Ely Parker was born Ha-sa-no-an-da on the Tonawanda reservation of the Seneca Indians in western New York in 1828... After being reared in Seneca tradition and receiving a non Seneca education, Ha-sa-no-an-da, who had by now adopted the English name Ely Parker, was called upon by his elders to act as spokesman for his people in a conflict with the federal government over Tonawanda lands. Parker studied to practice law, but because of his race, New York State law would not allow him to practice "before the bar." Parker then attended Rensselaer Polytechnic Institute and became a civil engineer. It was while he was supervising the construction of the U.S. Customs building in Galena, Illinois, that Parker began his friendship with U.S. Grant ... And, so it was that Ely Parker ended up in the parlor of the Mclean house on that Palm Sunday afternoon in April 1865, writing out the official copy of the terms of surrender of General Lee's Army of Northern Virginia. {Note – While an intriguing story, there is no record that he ever attended RPI, which shows how much we can rely on Wikipedia. –KC}

Question I: Astable Multivibrator (20 points)

For this circuit: $V_1 = 4V$ and $R_{load} = 10k\Omega$

1. (4 pts) The 555 timer circuit shown is to have a duty cycle of 52.4%. For a given C_1 , what ratio of resistors R_1/R_2 will produce this duty cycle?

$$\frac{R_1 + R_2}{R_1 + 2R_2} = 0.524 \text{ or } \frac{R_1}{R_2} = 0.1$$

2. (4 pts) Using a ratio from above and $C_1 = 4700\mu F$, calculate the values for R_1 and R_2 needed to yield an oscillation period of 53.58min?

Note the units.

$$T = 0.693 * (R_1 + 2R_2)C_1 = 0.693 * (R_1 + 20R_1)C_1 = 3214.8 \text{ or } R_1 = 47k\Omega \text{ and } R_2 = 470k\Omega$$

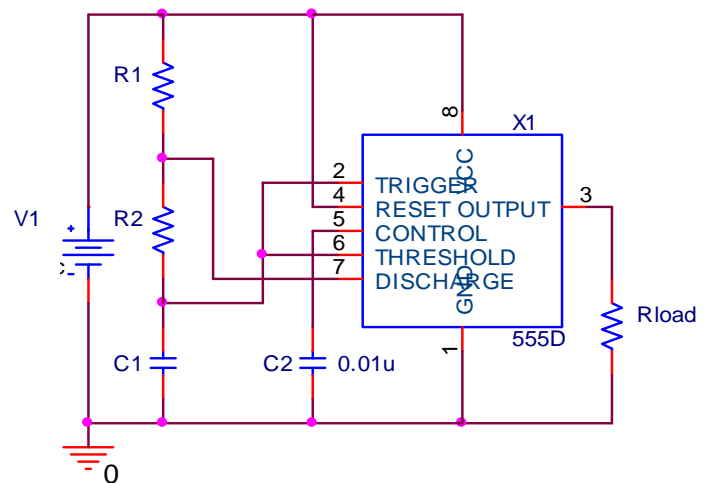
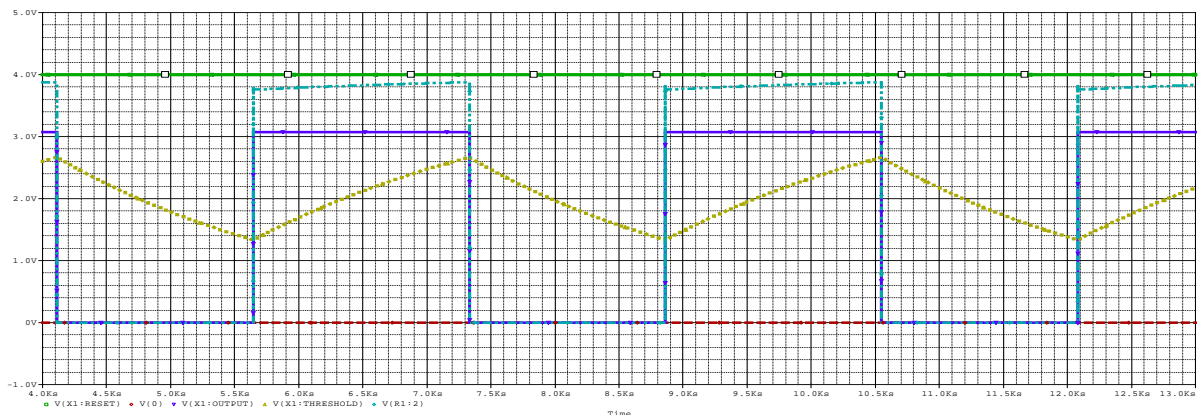
3. (2 pts) For an ideal 555, what are the maximum and minimum voltages on pin 2 above during normal operation?

$$V_{min} = 1/3 V_1 = 1/3 \times 4 = 4/3V \quad V_{max} = 2/3 V_1 = 2/3 \times 4 = 8/3V$$

4. (4 pts) For an ideal 555, what are the maximum and minimum voltages on pin 7 above during normal operation?

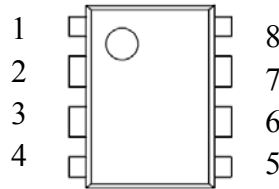
$$V_{min} = \text{ground} = 0V \quad V_{max} = R_2/(R_2+R_1) \times (4 - 8/3) + 8/3 = (10/11)(4/3) + 8/3 = 3.88V$$

5. (6 pts) The plot below shows the voltages on pins 8, 3 and 1 for the circuit above. The vertical scale goes from 0V to V and the horizontal scale goes from 8s to 10s. Label each voltage with the pin number. Then draw the voltages on pins 2 and 7 of the circuit above and label each with its pin number. *Note that the voltage on pin 7 goes to 3.88V and on pin 2 from 4/3 to 8/3.*

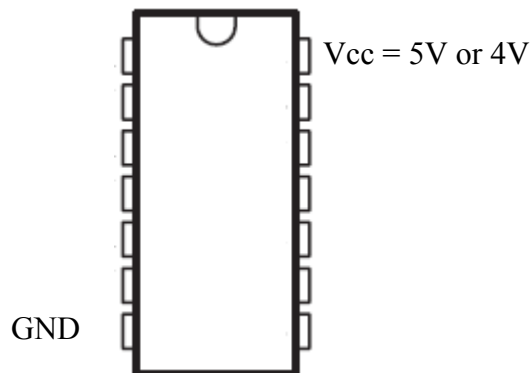


Question II: Practical Circuit Issues & Relays (20 points)

1. IC chips have a standard numbering convention that you should now know. Label pins #1-8 on the IC below. (HINT: It doesn't matter what the chip's function is – just label #1, #2, ...). (2 pts)



2. Like op-amps, IC chips need two power connections in order to function. Label the power (V_{cc}) and ground pins on the 7404 IC chip pictured below with the appropriate *voltage values*. (2 pts)

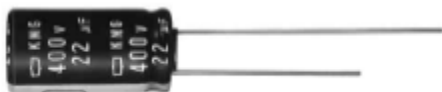


3. The 7404 chip contains more than one inverter. How many does it contain? (2 pts)

6

4. You've primarily used two types of capacitors in the studio: electrolytic and ceramic disc, each shown below:

Electrolytic:



Ceramic Disc:



Which one is polarized (e.g. has a + and – lead) (circle one)? (2 pts)

neither

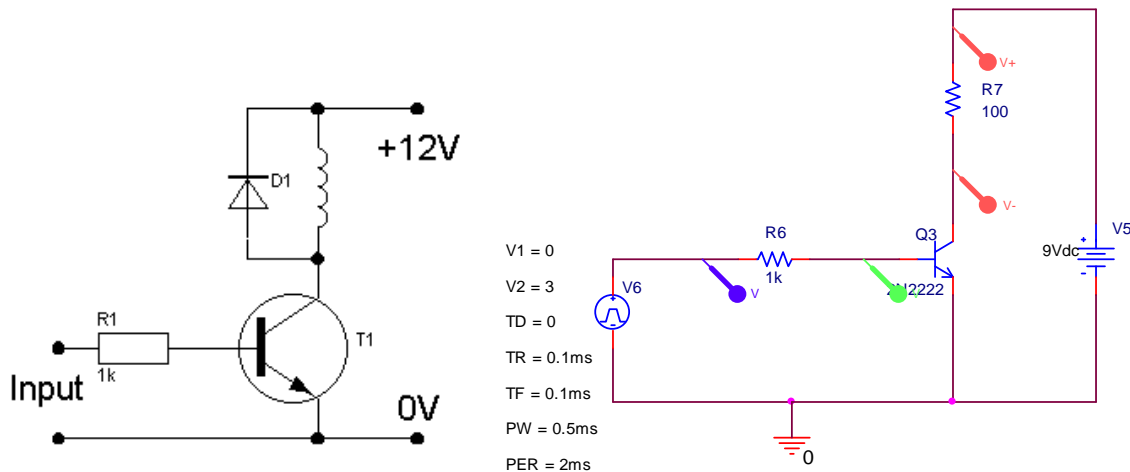
electrolytic

ceramic disc

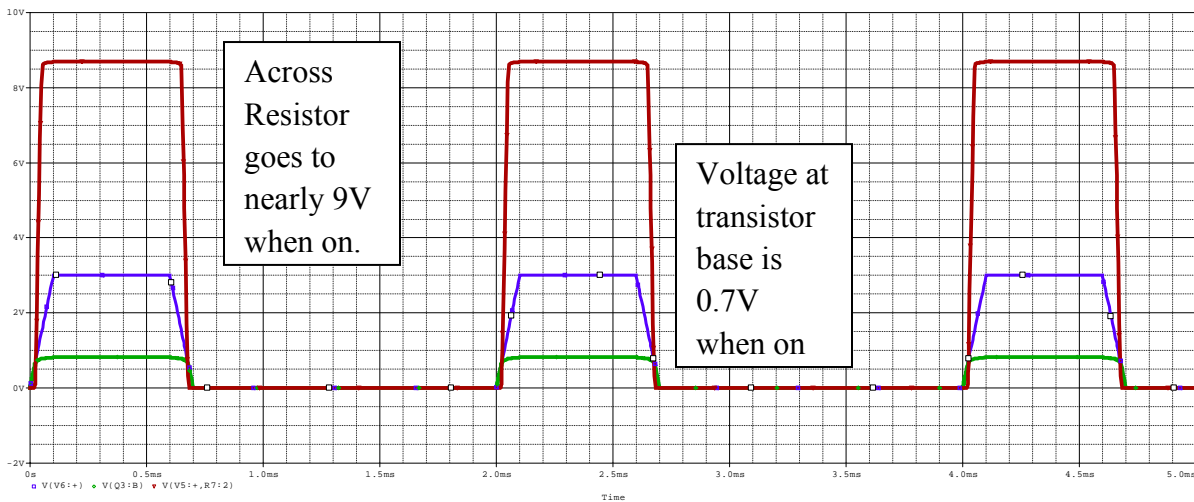
both

Question II: Practical Circuit Issues & Relays (continued)

5. We used one circuit configuration in class to drive a relay with a transistor. A simpler and generally more popular circuit is shown below. This image comes from a website with information on programming PIC chips (<http://www.winpicprog.co.uk/>). Shown also is a simplified version of the circuit (from PSpice), in which the relay is replaced by a resistor and the diode is removed. We will return to the diode, but for now assume that is not in the circuit.

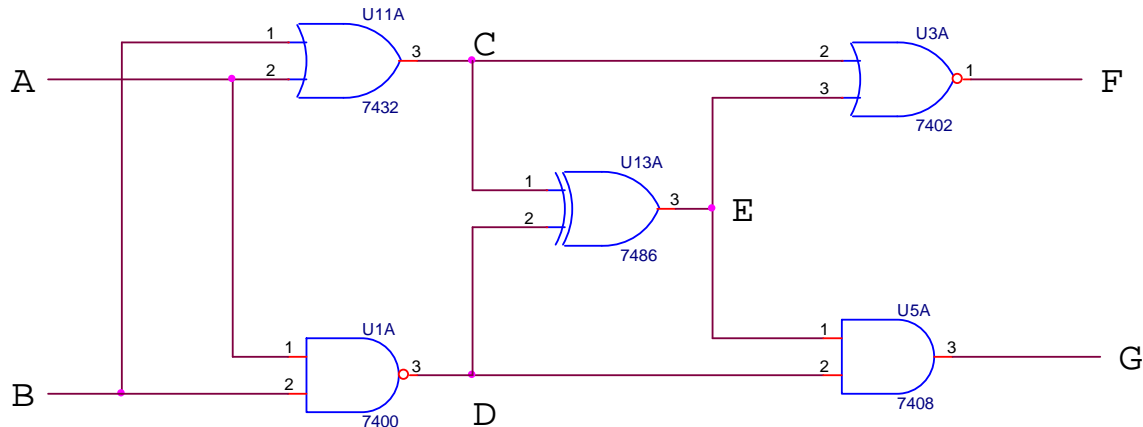


The input voltage is plotted below. Sketch the voltage at the base of the transistor and across the resistor (R7) that represents the relay. The vertical scale is from 0V to 10V. (8 pts)



6. Why is the diode necessary in this circuit? *Hint: what other circuit component (besides a resistor) must be used to accurately model a relay coil?* (4 pts)

The coil has inductance in addition to resistance. When the voltage to the coil is switched off, the current wants to continue to flow or a very large voltage spike will be created. The diode provides a path for the current, which will decay to zero because of the resistance.

Question III: Combinational Logic Circuits (20 points)

1. Complete the table below for the circuit above. (10 pts)

A	B	C	D	E	F	G
0	0	0	1	1	0	1
0	1	1	1	0	0	0
1	0	1	1	0	0	0
1	1	1	0	1	0	0

2. What type of gate is output G above, if any? (circle one) (2 pts)

AND NAND OR NOR **XOR** NOT None of the others.

3. A logic circuit similar to that in a) (but NOT the same) has the following truth table. Combining CD as a 2-bit binary number, fill in the decimal value in the table. (4 pts)

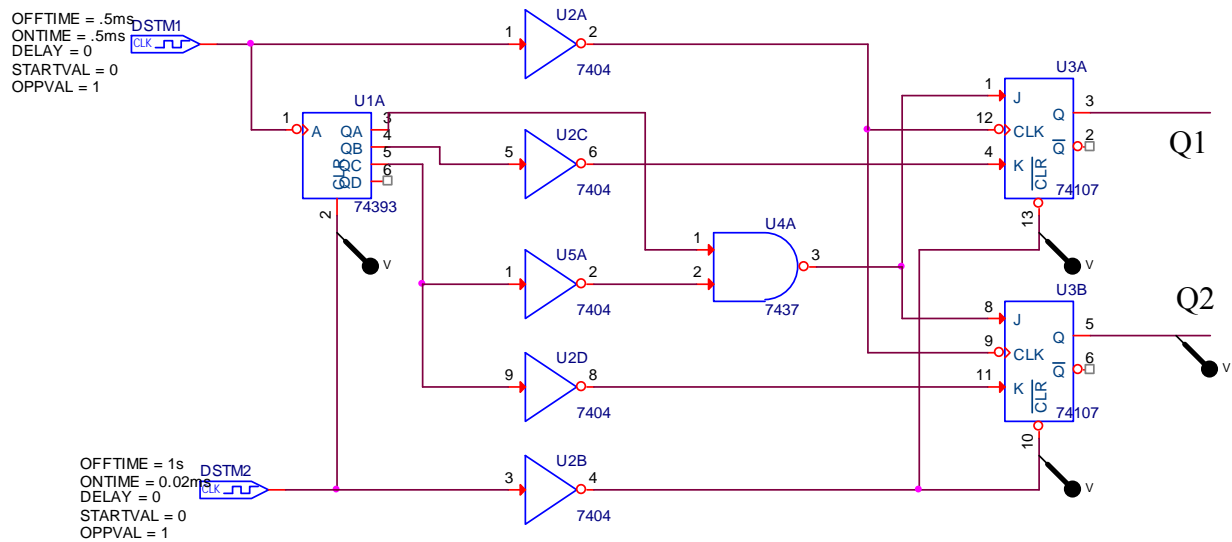
A	B	C	D	CD as Decimal Number
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	0	2

4. If A and B are treated as binary number inputs, what **Arithmetical** operation is being performed in creating the output CD? (4 pts)

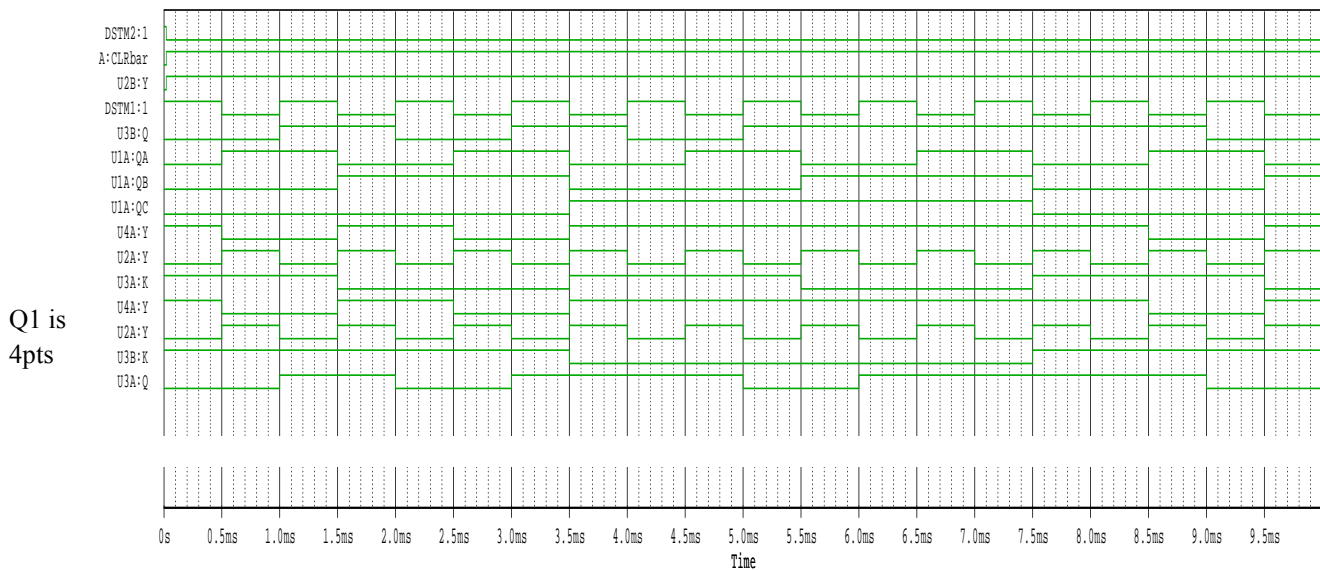
Addition

Question IV: Sequential Logic Circuits (20 points)

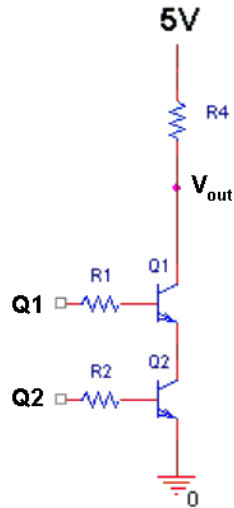
You are given the following circuit DSTM1 provides the clock for the counter. $\overline{DSTM1}$ provides the clock to the two flip flops. DSTM2 provides an initial reset pulse to all the sequential chips. Therefore, you can assume that QA, QB, QC, QD, Q1, and Q2 are all initially low.



1. Sketch the timing trace for each of the signals shown. Note that Q1 is U3A:Q and Q2 is U3B:Q. The latter is given, but you need to sketch the remaining signals. (13 pts total)



2. We take the output of this circuit and use it as the input to the transistor circuit shown below:



Fill in the following table for all possible values of Q1 and Q2. (4 pts)

Q1	Q2	Vout
0V	0V	5V
0V	5V	5V
5V	0V	5V
5V	5V	0V

The output is not really 0V but closer to 0.5V because of the junction drop.

3. What are the values of the signals at Q1, Q2 and Vout after 9 milliseconds? (3 pts)

Q1: 0V

Q2: 0V

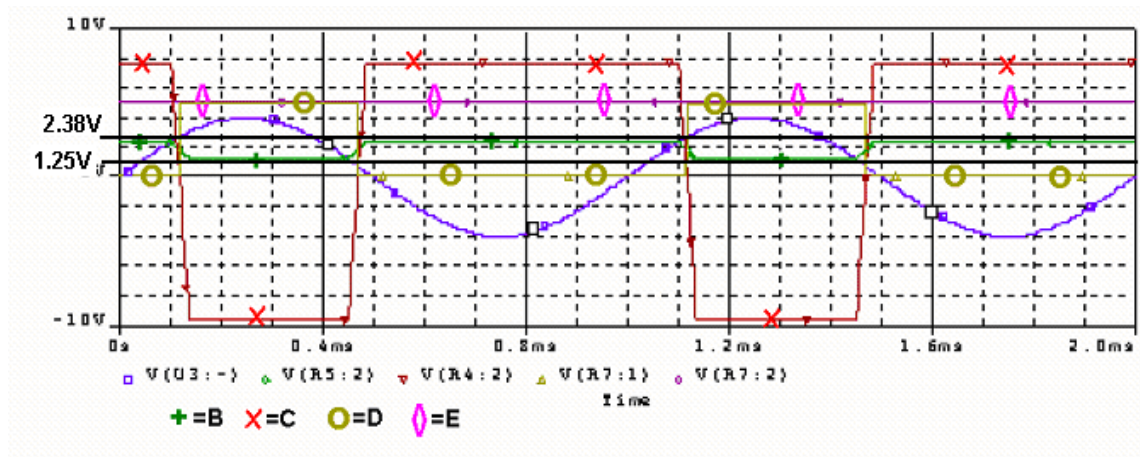
Vout: 5V

5. On the following plot, the input at point A is shown.

- Mark the upper and lower thresholds of the hysteresis (2 pts), and
- sketch and label the output at points B, C, D and E for the input shown. (8 pts)

Many of the signals will overlap. Use the PSpice labeling convention to identify the signals by drawing unique symbols on *important parts* of each trace. Note that the input has a little box.

Use the following: B = + C = × D = O and E = ◇.



Signals change when input rises above 2.38V or falls below 1.25V

Signal B toggles between 1.25 and 2.38 volts. (H-L-H-L-H)

Signal C toggles between +8V and -10V (H-L-H-L-H)

Signal D toggles between 0V and some voltage less than 5V (L-H-L-H-L) (You do not know enough about diodes to know the exact voltage, so we accepted anything in this range that was recognizable as not zero.)

Signal E is constant at 5V

6. Are the LEDs on or off at the following times? (3 pts)

time	LED1	LED2
0.3ms	ON	ON
0.8ms	OFF	ON
1.2ms	ON	ON