ECEN 449 - Microprocessor System Design
Test #2

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Fall 2015

NAME:

SECTION:

Problem	749 points	449 points	Your points
Problem 1	30	30	
Problem 2	35	35	
Problem 3	35	35	
Problem 4 (GRADUATE)	25	0	
Total	125	100	

For all your answers which involve Verilog code or C code, you should provide comments in your code for full credit.

For other answers, you must provide comments about *how* you obtained the answer for full credit.

If you give me more than one answer for the same question, I will grade all your answers, and score your points for the answer which obtained the least points.

For a question with N points, I suggest that you budget 1.2 $\times$ N minutes for it.

The speed of light is $c = 3 \times 10^8$ m/s

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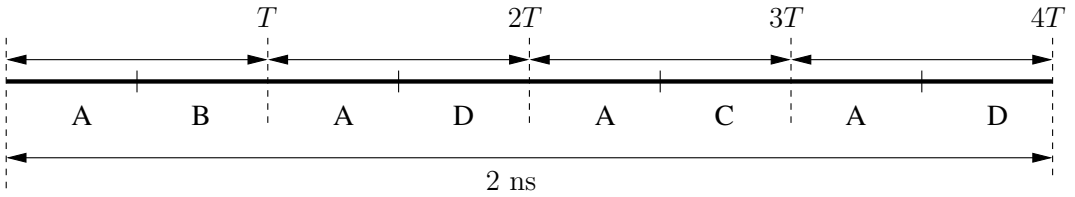
1. Consider a pulse modulation scheme which is illustrated in the figure below. The scheme is used to transmit 4 analog signals (SA, SB, SC and SD). Assume that the analog signals have a peak-to-peak amplitude of 1 Volt. These signals are sampled to generate 4 modulated signals A, B, C and D respectively. These modulate signals are transmitted in the sequence shown in the figure below, over a period of 2ns. Between 0ns and 2ns, 2ns and 4ns, 4ns and 6ns ... , the signals are transmitted in the sequence shown below.

   The signal A is modulated using PWM with 5 values. Signal B is modulated using PCM, with 5 bits. Signal C is modulated with PPM, with 5 slots. Finally, signal D consists of 5 PAM-9 values.



   (a) What is the sampling frequency for each of SA, SB, SC and SD?

   (b) What is the bandwidth of each of the signals SA, SB, SC and SD?

   (c) What is the effective number of bits/second transmitted by each of the signals A, B, C and D.

   (d) When the signals A, B, C and D are de-modulated, what is the precision (in terms of voltage) with which each of the voltages of the original signals SA, SB, SC and SD are reconstructed?

   Now let's suppose that instead of the modulation scheme shown above, I combine the data for SA, SB, SC and SD in a single PCM signal, transmitted over 2ns

   (e) How many bits would I need to transmit (using PCM) in 2ns?

   (f) What would be the sampling frequency for each of SA, SB, SC and SD in this case?

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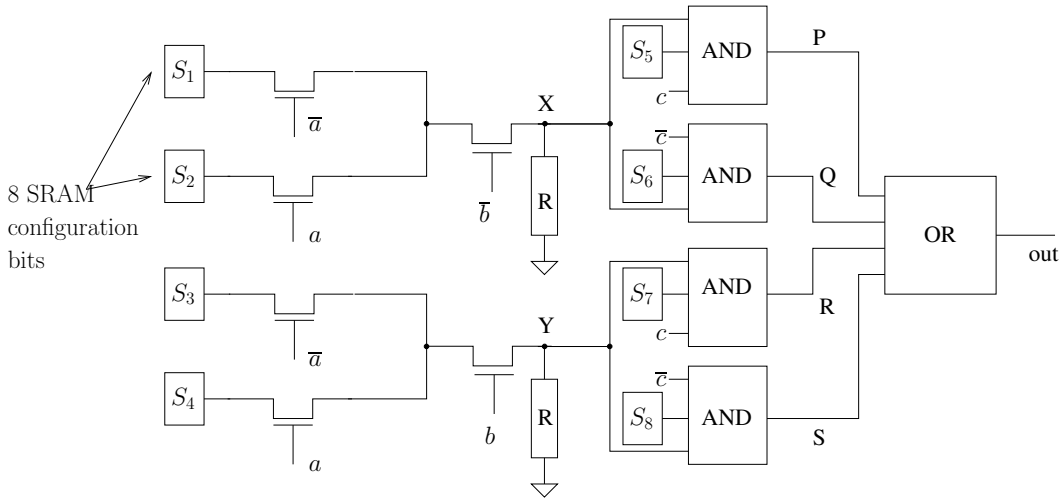
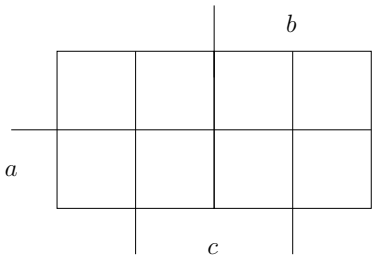
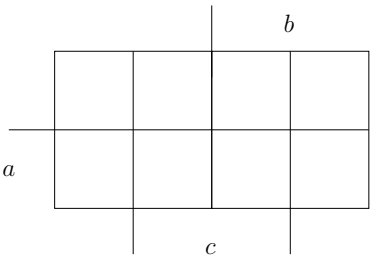
2. Consider the circuit drawn below. In this circuit, assume that each NMOS transistor has a resistance of 4KΩ when it its gate signal is VDD, and it is open circuited when its gate signal is GND. The value of the resistor R is 1MΩ.



a) Circuit



K−map for part b



K−map for part c

(a) Write down the logic functions for the circuit nodes X, Y, P, Q, R and S.

(b) Fill in the the K-map **on the left** with the logic function of the circuit shown above.

(c) Suppose the value of R is changed to 1KΩ. Fill in the the K-map **on the right** with the logic function of the circuit shown above, but with the new value of R.

(d) Why do we need the resistor R in the circuit?

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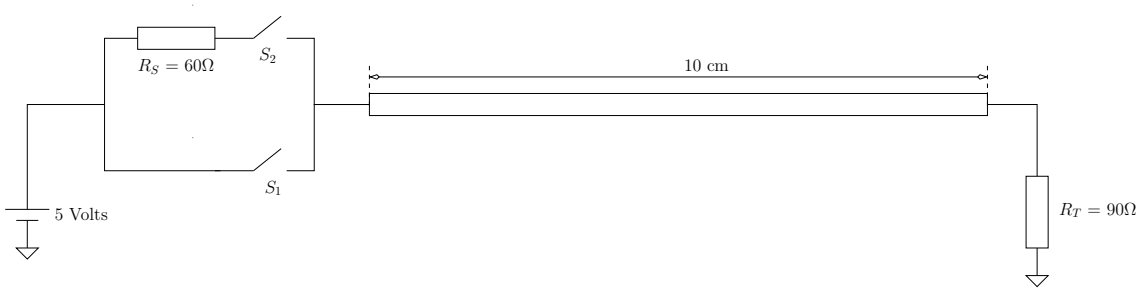
3. Consider the transmission line shown below. The length of the line is 10cm. The inductance per unit length $L = 346.41$ nH/m, and the capacitance per unit length is $C = 96.225$ pF/m. The line is terminated by $R_T = 90\Omega$ as shown. The resistance $R_S = 60\Omega$.

   The line is driven (on the left of the figure) via two switches S_1 and S_2. Both switches in the figure are shown in the *open* condition (i.e. they are open-circuited).

   Up until time $t = 0-$, both switches stay open. At time $t = 0+$, S_1 is closed, while S_2 stays open. At time $t = 2 \cdot t_d-$, we close S_2, and open S_1. By t_d, we mean the time of flight of the signal in the transmission line.



   (a) What is the voltage of the line, as a function of the distance x from the source, at time $t = 0-$?

   (b) What is the relative dielectric constant κ of the dielectric material in which the transmission line resides?

   (c) Draw the voltage waveform at the termination end of the transmission line, as a function of time.

   (d) Draw the voltage waveform at the mid-point of the transmission line, as a function of time.

   (e) Draw the voltage waveform at the source end of the transmission line, as a function of time.

   (f) What is the frequency with which the termination end of the transmission line will ring?

   (g) Suppose R_S was chosen to be 10Ω. What is the frequency with which the termination end of the transmission line will ring?

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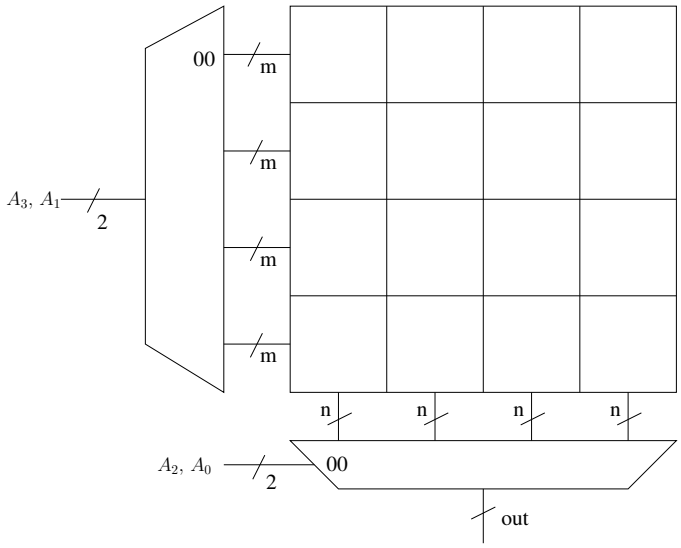
4. Consider the memory shown below. It is accessed 16 bits at a time, and has a total of 16 entries labeled D0 through D15. The memory is accessed via an address which consists of 4 bits A3 through A0. A3 is the MSB of the address.

   Any address accesses the data entry whose index is the numerical value of the address. For example, the address 1001 accesses the data entry D9. In the figure, when a bus is driven by multiple signals, the leftmost signal is the MSB. For example, if a 3-bit bus is driven by p, q and r, then p is the MSB.



   (a) In the figure above, fill in each of the 16 boxes with the data entry that resides in that box.

   (b) In the figure above, what are the values of m and n?

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