1. (1pts) What is the Hamming distance between these two bit patterns: 101101 and 101010?

2. (2pts) Write the equation for the carry out of the 4th adder cell in an ALU using carry-lookahead, in terms of P's and G's.

3. (3pts) Using a 4-1 mux, implement the following function:
   (X AND Y) OR (X AND !Z) OR (!Y AND !Z)

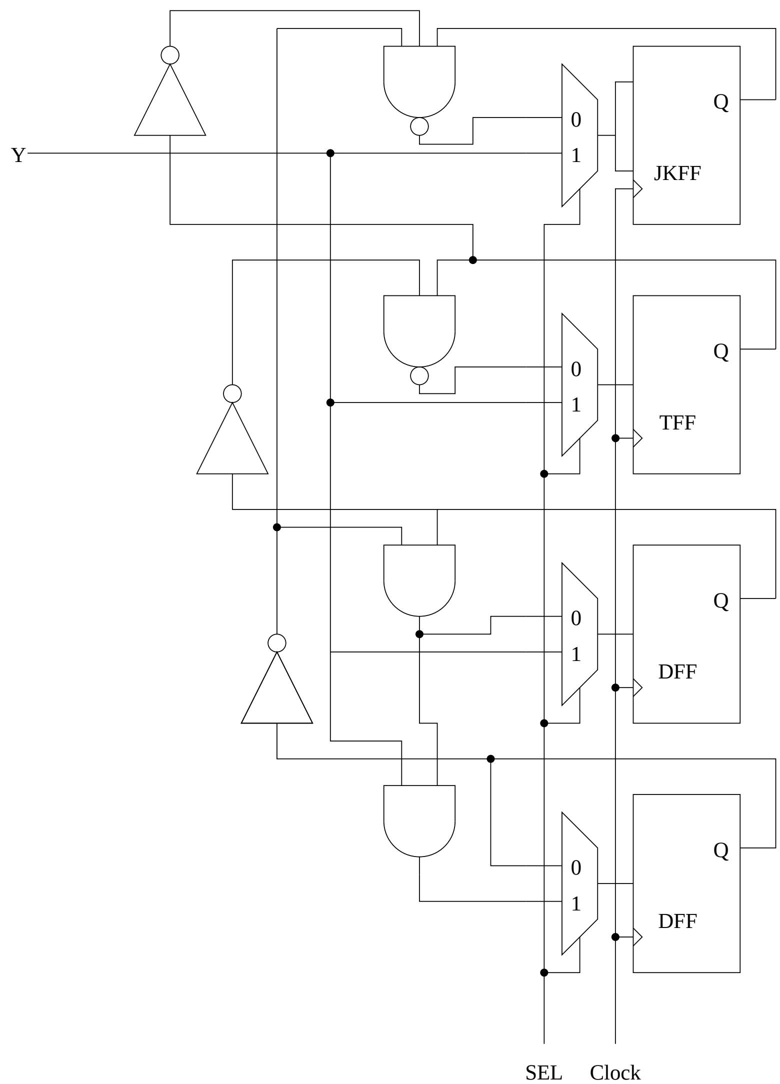
4. (4pts) What is the difference between the Mealy and Moore models of sequential design? What is the advantage to the Moore approach?

5. (2pts) What is the difference between a Flip-Flop and a latch?

6. (3pts) In the ALU you designed in the homework, how did you differentiate between an operation being an "add" and an operation being a "subtract"? In other words, what bit/bits were set/cleared in order to indicate that the values were to be added instead of subtracted? Why did this work so well?

7. (10 pts) Assuming rising edge-triggered flipflops, what is the maximum clock frequency possible for the following circuit? (In other words, what is the maximum clock frequency that will still guarantee correct behavior?) Use the following delay values, and assume all input signals become valid at time 0. (Tprop is the propagation time for the flipflop, the time it takes from the rising edge of the clock until the output of the FF is valid.)

AND: 3ns NAND: 4ns NOT: 2ns MUX: 5ns
Tprop (DFF): 7ns Tsetup (DFF): 2ns Thold (DFF): 3ns
Tprop (TFF): 8ns Tsetup (TFF): 3ns Thold (TFF): 2ns
Tprop (JKFF): 9ns Tsetup (JKFF): 4ns Thold (JKFF): 2ns



8. (3pts) How far apart must valid code words be to allow Triple (3) Error Detection (TED)?
Quintuple (5) Error Correction (QEC)?
Septuple (7) Error Correction octuple (8) Error Detection (SECOED)?

9. (10 pts) Here is a 12-bit Error Correction code format (same one used in class):

$$d_8 \;\; d_7 \;\; d_6 \;\; d_5 \;\; C_4 \;\; d_4 \;\; d_3 \;\; d_2 \;\; C_3 \;\; d_1 \;\; C_2 \;\; C_1$$

a. Given the *data* bit pattern

1 0 0 0 0 1 1 0

in a machine using the above ECC code, what bit pattern gets sent to memory? (No credit will be given without work being shown.)

b. In this same machine, the following bit pattern is retrieved from memory:

0 1 0 0 0 1 1 0 0 1 1 1

Assuming the above Error Correction code format, identify and correct any errors that may have occurred during transmission or storage. (No credit will be given without work being shown.)

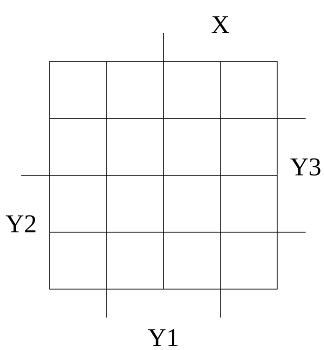
10. (11 pts) You have been asked to create a new flipflop, which has two inputs - the "TE" and the "ST". All you have to work with is a JKFF. The TESTFF is to exhibit the following behavior:

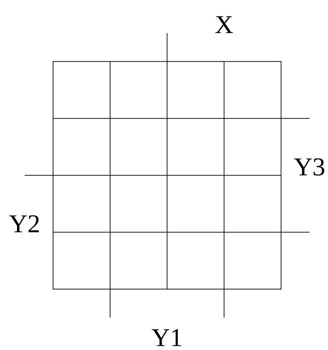
Present State		Next State
TE	ST	Z'
0	0	0
0	1	1
1	0	Z
1	1	Zbar

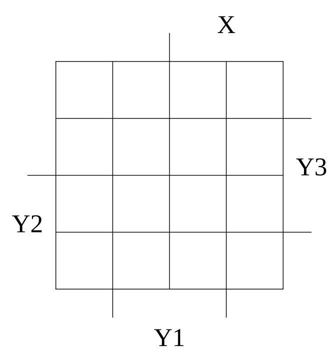
Write down what the J and K inputs must be (in terms of TE, ST, and Z) in order to provide the desired functionality. Be sure to minimize the equations.

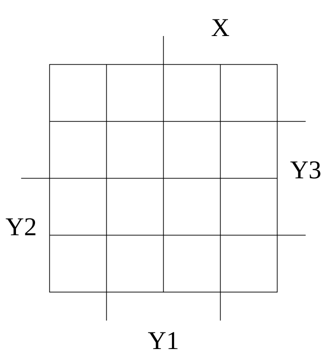
11. (16) Given the following table, draw the Karnaugh maps for Y1’, Y2’, and Y3’ and Z in terms of X, Y1, Y2 and Y3, and then write **minimum** boolean equations for each.

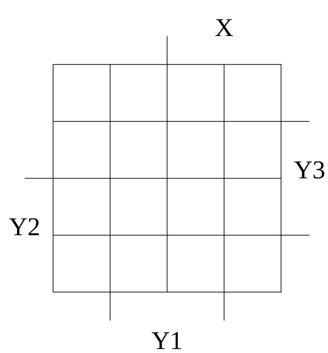
Present State (Y1 Y2 Y3)	Next State X=0 (Y1’ Y2’ Y3’)	Next State X=1 (Y1’ Y2’ Y3’)	Output X=0	Output X=1
000	111	010	0	0
010	110	010	0	1
100	010	010	0	0
101	000	111	1	0
110	000	000	0	0
111	000	101	1	0

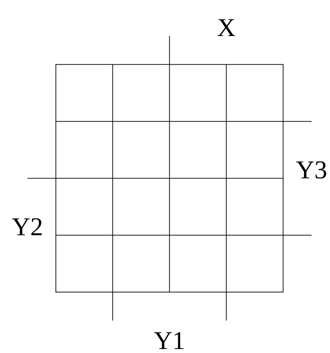












12. (15 pts) Given the following Karnaugh maps, implement the sequential machine using an SR FF for Y1, a JK FF for Y2, and a T FF for Y3. You do not need to draw the gates, but you do need to write down the **minimized** input equations for each of the inputs of each of the Flip Flops in the circuit.

Y1'

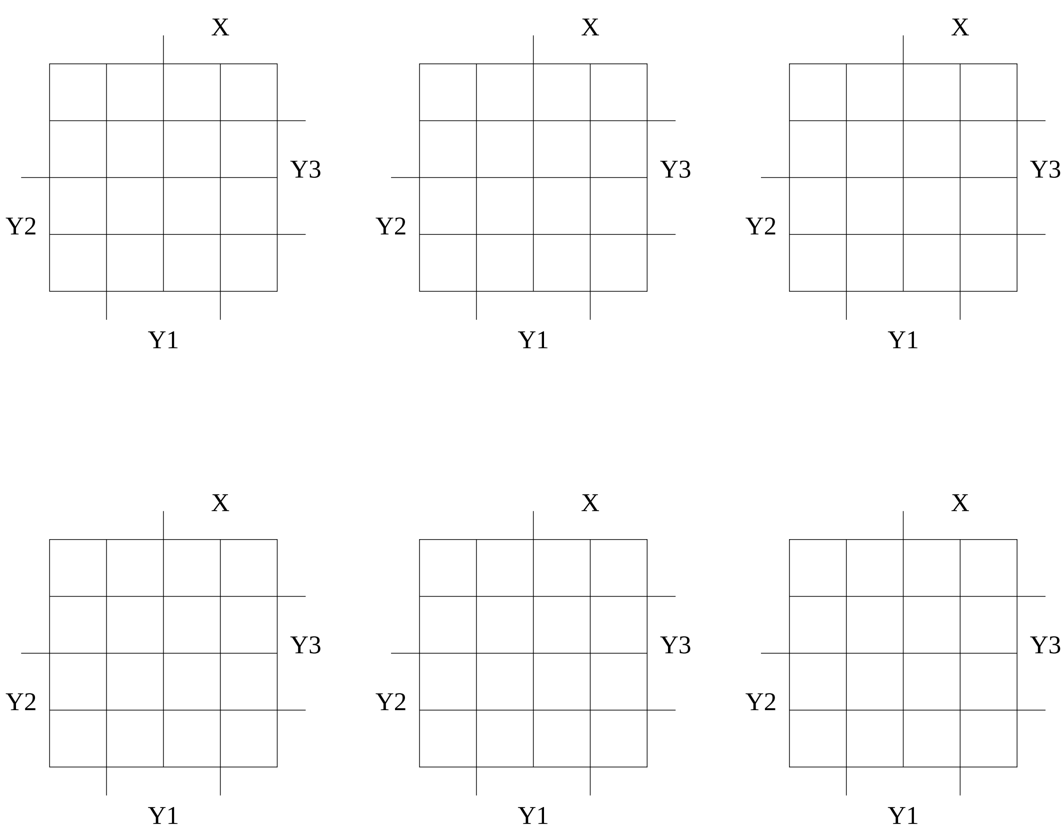
		Y1	Y1, X	X
	1	1	1	d
Y3				
Y2, Y3		1	1	1
Y2	1	1	1	d

Y2'

		Y1	Y1, X	X
	1			d
Y3				1
Y2, Y3				
Y2	1	1	1	d

Y3'

		Y1	Y1, X	X
			d	1
Y3	1	1	1	
Y2, Y3		1	d	
Y2		1		d



13. (20 pts) The President of Freedonia (Rufus T. Firefly) suspects his Prime Minister has been using the presidential restroom without permission. The President is incredibly cheap, but not without heart - therefore, has decided to make some modifications and turn it into a pay toilet with a twist: you don’t have to pay to get in, but you have to pay to get access to the toilet paper. (Gives new meaning to the phrase "pay as you go", doesn’t it? :-) You have been hired to make the necessary modifications. The President wants the toilet paper dispenser to accept two coins, the 5 Quatloo piece (the "nickeloo") and the 10 Quatloo piece (the "dimeloo"). Access to the toilet paper costs 25 Quatloos, and the dispenser must give change. Let X1 be the ten Quatloo coin and X2 the five Quatloo coin, and assume both coins cannot be inserted simultaneously (no matter how much of a hurry the user is in.) Therefore, 10 = a dimeloo inserted, 01 = a nickeloo.

Draw the State Transistion Diagram (the circles and the arcs) for this finite state machine. Let S0=no money input (the Start state). Once you have a state transition diagram, minimize the number of states necessary and then assign bit patterns to each state and write down the corresponding state transition table. Assume you are using a Mealy model. Label the transitions on the diagram using the format we used in class (inputs over outputs).