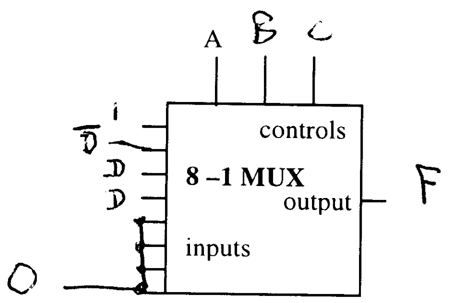
1. (11 points) Your input is in BCD and A is the most significant bit. Your output, F, should be 1 if the input is a digit in today's date, 11/17/2005 (0, 1, 2, 5, 7). Otherwise, the output should be 0. Implement this function using only the 8-1 MUX below and no additional hardware. A small part of the problem (where to put the "A" input), is already solved for you. You should also fill in the truth table, and will find the problem much easier if you do the truth table first.



Other correct solutions exist for the don't cares.

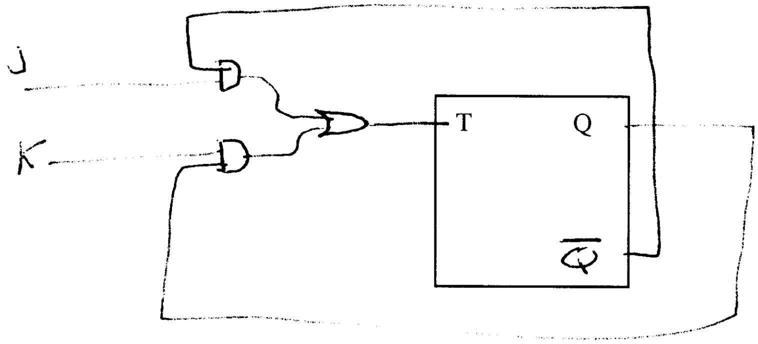
Truth Table for Problem 1

A B CD	F	F(D)
0000	1	1
0001	1	
0010	1	$\bar{D}$
0011	0	
0100	0	D
0101	1	
0110	0	D
0111	1	
1000	0	0
1001	0	
1010	X	0
1011	X	
1100	X	
1101	X	
1110	X	
1111	X	

2. (10 points) Design a JK flip flop, using a T flip flop". Draw the resulting system. You should use the K-map below to solve for the logic. Do~~ing~~ the Moore diagram ~~is a~~ also. ~~good way to start.~~

J K	Q	Function
00	Q	Hold
01	0	Reset
10	1	Set
11	$\overline{Q}$	Toggle

J K Qt	Q^{t+1}	T
000	0	0
001	1	0
010	0	0
011	0	1
100	1	1
101	1	0
110	1	1
111	0	1

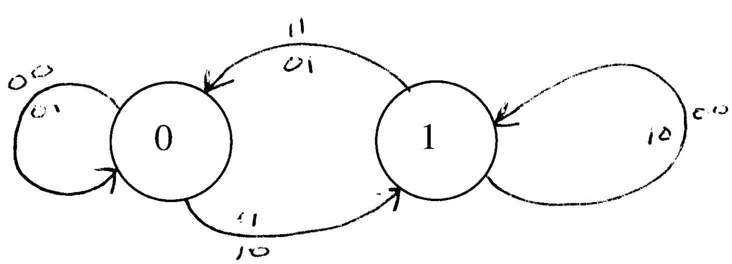


T = $J\overline{Q} + KQ$

J \ K Qt	00	01	11 KQ	10
0	0	0	1	0
1	1	0	1	1

$J\overline{Q}$

Moore Diagram



(4 pts)

3. Now design a T Flip-Flop using a JK flip flop. Draw the resulting system. You should use the K-map below to solve for the logic.

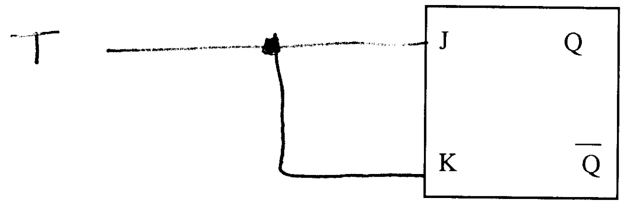
T Qt	Qt+1	J K
0 0	0	0 X
0 1	1	X 0
1 0	1	1 X
1 1	0	X 1

Use $J = K = T$

T	Q^{t+1}
0	Q^t
1	$\overline{Q^t}$

J K	Q	Function
0 0	Q	Hold
0 1	0	Reset
1 0	1	Set
1 1	$\bar{Q}$	Toggle

Q^t Q^{t+1}	J K
0 0	0 X
0 1	1 X
1 0	X 1
1 1	X 0



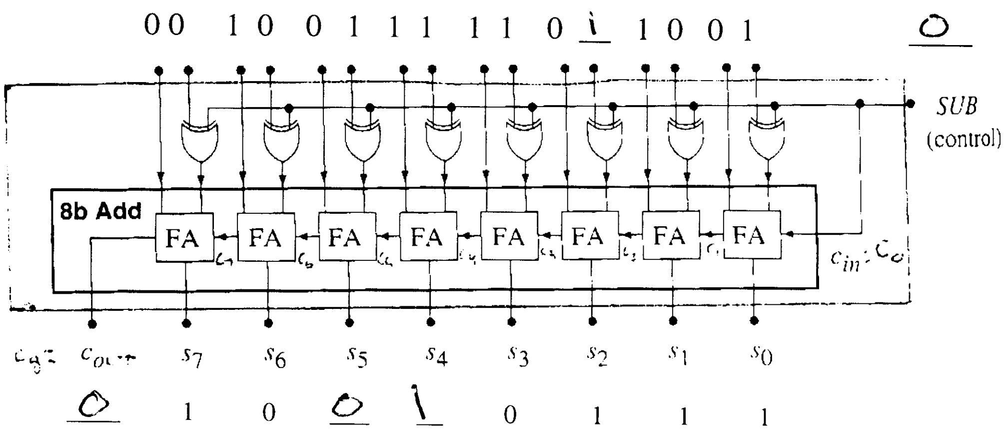
J = T

T \ Qt	0	1
0	0	X
1	1	X

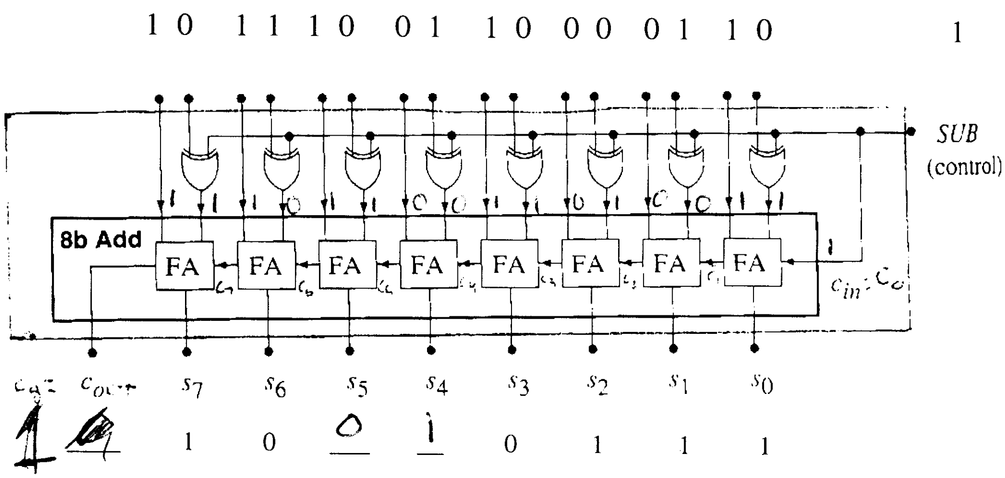
K = T

T \ Qt	0	1
0	X	0
1	X	1

4. (12 points) a) Label any missing quantities in the figure below.



b) Now label any missing quantities in this figure.



5. (8 points) Your input is an XS3 signal and your output is:

$$F = \begin{cases} 1 & \text{if the input is divisible by 3} \\ 0 & \text{otherwise.} \end{cases}$$

Find the minimal SOP form. $F = AB + A\bar{C}D + BC\bar{D}$

Other minimal solutions exist

	Decimal	ABCD	F
	0	0000	x
	1	0001	x
	2	0010	x
0	3	0011	0
	4	0100	0
2	5	0101	0
3	6	0110	1
4	7	0111	0
5	8	1000	0
6	9	1001	1
7	10	1010	0
8	11	1011	0
9	12	1100	1
	13	1101	x
	14	1110	x
	15	1111	x

$\bar{B}\bar{C}D$

AB \ CD	00	01	11	10
00	x	x	0	x
01	0	0	0	1
11	1	x	x	x
10	0	1	0	0

$\bar{A}C\bar{D}$

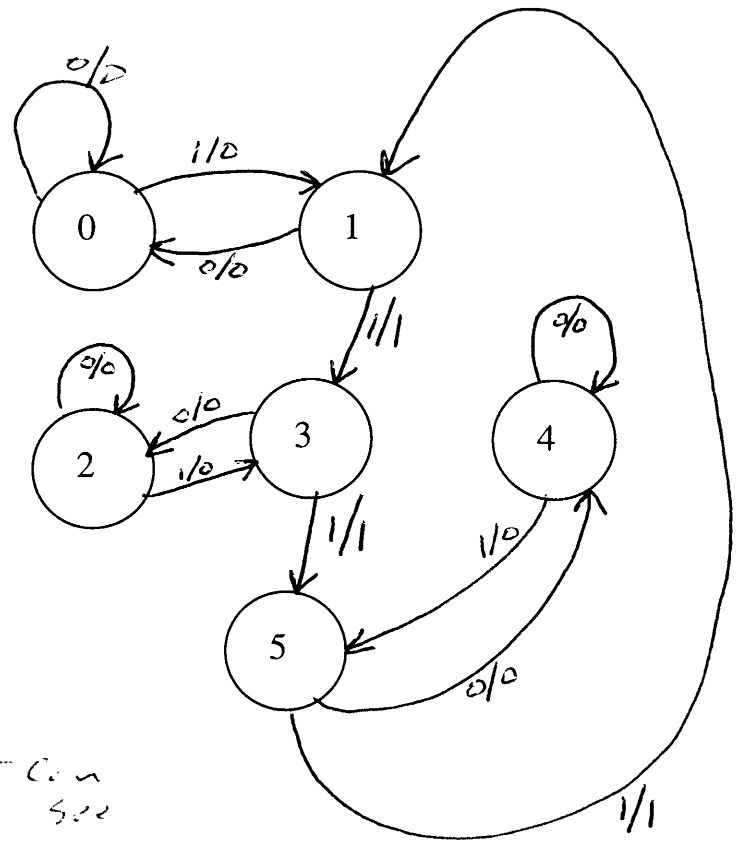
$BC\bar{D}$

AB

$A\bar{C}D$

6. (15 points) In the Mealy diagram below, the input variable is A, and output variable is Y. The state assignments MUST take the binary version of the numerical values shown. Implement this machine using D flip flops, by using the truth table on this page, and K-maps on the next page, to solve for the next-state and output logic. Take advantage of any don't cares that come up.

$AQ_2Q_1Q_0$	D_2	D_1	D_0	Y
0000	0	0	1	0
0001	0	0	0	0
0010	0	1	0	0
0011	0	1	0	0
0100	1	0	0	0
0101	1	0	0	0
0110	x	x	x	x
0111	x	x	x	x
1000	0	0	1	0
1001	0	1	1	1
1010	0	1	1	0
1011	1	0	1	1
1100	1	0	1	0
1101	0	0	1	1
1110	x	x	x	x
1111	x	x	x	x



Can see

$Y = AQ_0$

Can see

$D_0 = A$

6 (continued)

D2 = $\bar{A}Q_2 + Q_2\overline{Q_0} + AQ_1Q_0$.

AQ_2 \ Q_1Q_0	00	01	11	10
00	1	0	0	1
01	1	1	X	X
11	1	0	X	X
10	0	0	1	0

$Q_2\overline{Q_0}$

D1 = $Q_1\overline{Q_2} + \bar{A}Q_1 + A\overline{Q_2}\,\overline{Q_1}Q_0$.

AQ_2 \ Q_1Q_0	00	01	11	10
00	0	0	1	1
01	0	0	X	X
11	0	0	X	X
10	0	1	0	1

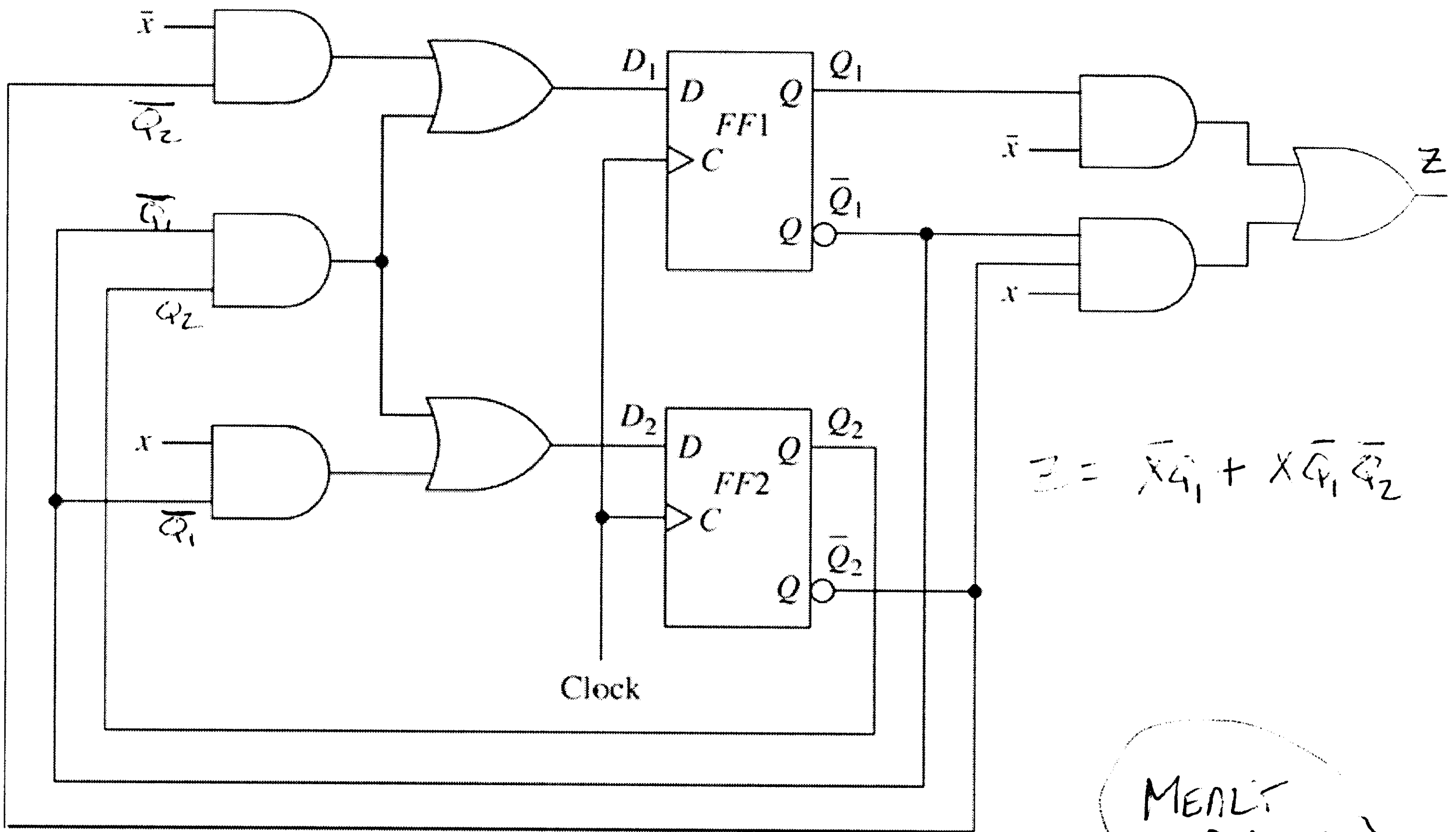
D0 = ______________________________.

AQ_2 \ Q_1Q_0	00	01	11	10
00				
01				
11				
10				

7. What is this device doing? Construct the state transition and excitation tables (all on the same table) and generate the state transition diagram.

$$D_1 = \bar{x}\bar{Q_2} + Q_2\bar{Q_1} = \cancel{(\bar{x}+\bar{Q_1}Q_2)\bar{Q_2}}$$

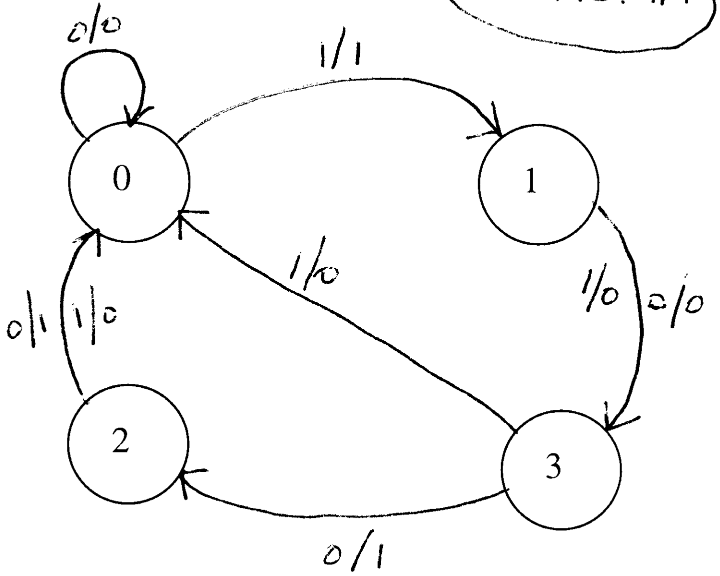
$$D_2 = x\bar{Q_1} + \bar{Q_1}Q_2 = \bar{Q_1}(x+Q_2)$$



$$Z = \bar{x}Q_1 + x\bar{Q_1}\bar{Q_2}$$

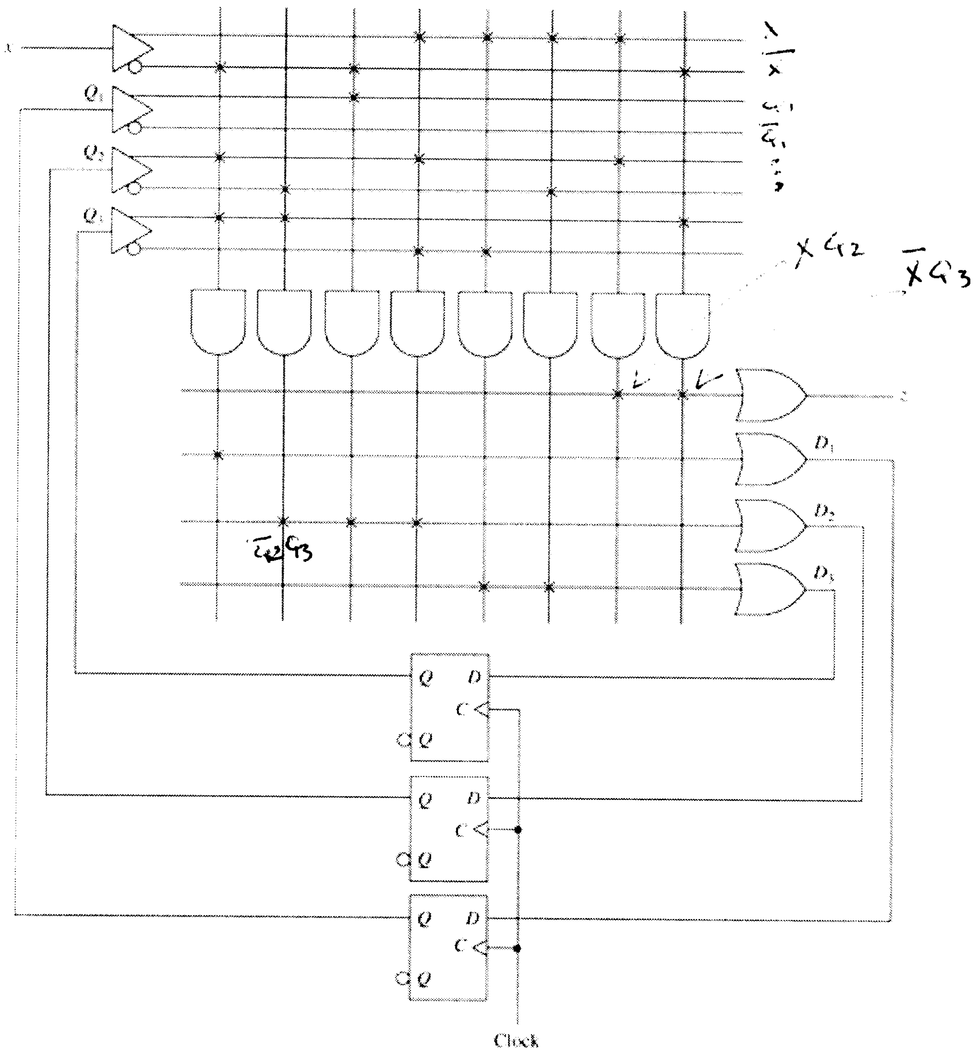
MEALY DIAGRAM

X Q1 Q2	D1	D2	Z
000	1	0	0
001	1	1	0
010	1	0	1
011	0	0	1
100	0	1	1
101	1	1	0
110	0	0	0
111	0	0	0



(3 pts)

8. Write down the flip-flop excitation equations and output equation for the PLA shown below. You only have to write down the equations.



Z = $X Q_2 + \bar{X} Q_3$.

D1 = $\bar{X} Q_2 Q_3$.

D2 = $\bar{Q}_2 Q_3 + \bar{X} Q_1 + X Q_2 \bar{Q}_3$.

D3 = $X \bar{Q}_3 + X \bar{Q}_2$.

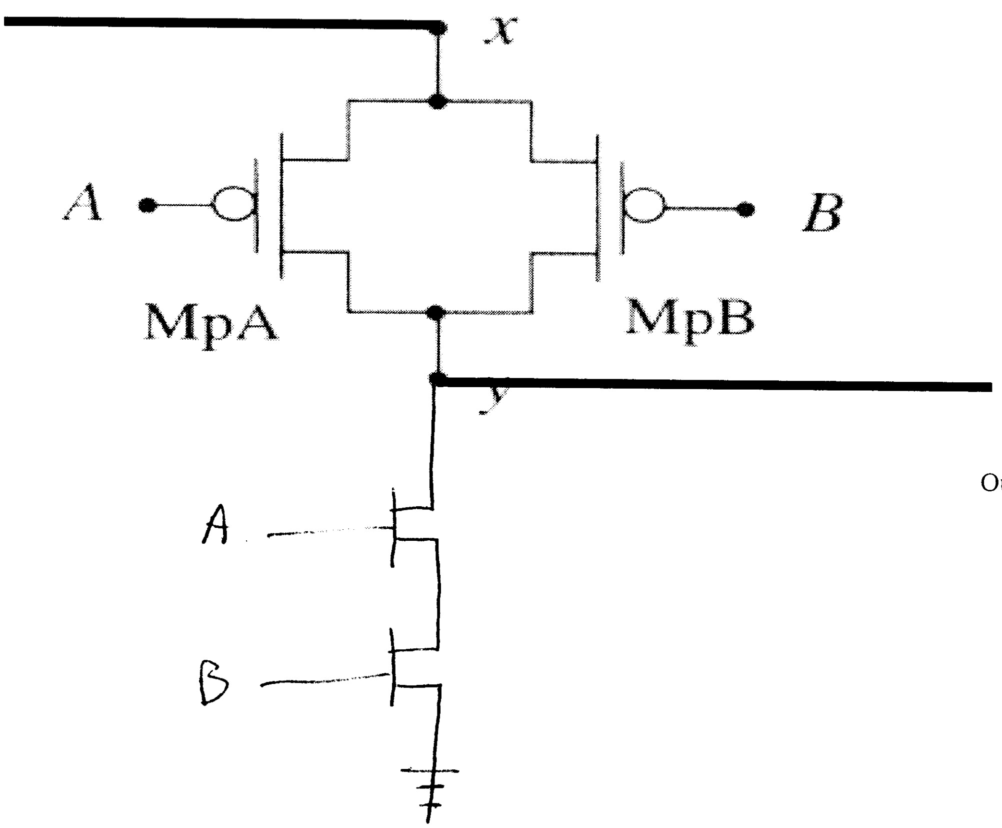
7/15

9. Identify this half-drawn CMOS device by completing the drawing, then filling in the truth table and interpreting its behavior. Alternatively, you are permitted to guess (but you still have to complete the drawing correctly).

This device is a(n) NAND GATE.

A B	Y
0 0	1
0 1	1
1 0	1
1 1	0

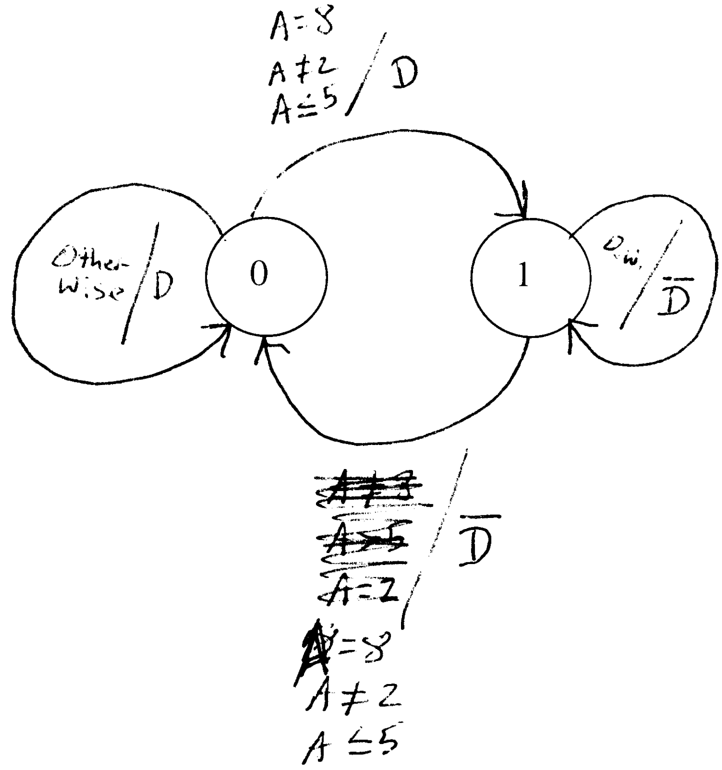
VDD = x



Output = y = $\overline{AB}$

10. (14 points) (Note: The decimal column isn't of much use except to help keep track of where you are.) Your input is in binary, and your output is as described below. If your input is greater than five, you will keep the same state. If it is less than or equal to five, you will change state. However, there are two exceptions to this rule. If your input is 8, you will change state, and if your input is 2, you will keep the same state. Your output is the state if your input is even, and the complement of the state if the input is odd. You can solve for the logic by using basic gates: AND, OR, INVERTER, NAND, NOR, XOR. Use the five-variable truth table and K-map. You probably won't need either the truth table or K-map for the output, Y. But, as long as your answer is correct, it is fine. Your binary input variables are ABCD, your state is Q, and you must use a T flip-flop to represent the state. Show the Mealy diagram on this page, and the rest of the solution on the following pages. Try not to be too messy with the Mealy diagram – you can use one arc for more than one input...

Decimal	ABCDQt	Qt+1	T	T(Y)
0	00000	1	1	
1	00001	0	1	1
2	00010	1	1	1
3	00011	0	1	
4	00100	0	0	0
5	00101	1	0	
6	00110	1	1	1
7	00111	0	1	
8	01000	1	1	1
9	01001	0	1	
10	01010	1	1	1
11	01011	0	1	
12	01100	0	0	0
13	01101	1	0	
14	01110	0	0	0
15	01111	1	0	
16	10000	1	1	1
17	10001	0	1	
18	10010	0	0	0
19	10011	1	0	
20	10100	0	0	0
21	10101	1	0	
22	10110	0	0	0
23	10111	1	0	
24	11000	0	0	0
25	11001	1	0	
26	11010	0	0	0
27	11011	1	0	
28	11100	0	0	0
29	11101	1	0	
30	11110	0	0	0
31	11111	1	0	



7 $Y = D \oplus Q^t = D\bar{Q}_t + \bar{D}Q_t$

10 (Continued)

T = $\bar{A}\bar{C} + \bar{A}\bar{B}D + \bar{B}\bar{C}\bar{D}$

AB \ CD	00	01	11	10
00	1	1	1	0
01	1	1	0	0
11	0	0	0	0
10	1	0	0	0

$\bar{B}\bar{C}\bar{D}$

10 (Continued)

Y = $D \oplus C^{2}$

AB \ CD	00	01	11	10
00				
01				
11				
10				

10 (Continued)

Draw your state transition and output logic here.