ECEN3233 Spring 2007

Exam 2

Thursday, March, 29th

10:30am-11:20am

(Total Points 100)

Name: Solutions

Note:

1. This exam is closed book and closed notes. You can bring one single-sided sheet.
2. Totally 8 pages including this cover page.
3. Read each question carefully. If something appears ambiguous, clearly state your assumptions. Clearly indicate each answer by enclosing it in a box. Show all your work.
4. By taking this exam you agree that all work is your own. All work is to be done on the attached sheets – use the backs only if necessary. Clearly identify your work. Failure to follow instructions may result in a reduction in your score.

1. True or False (20 points)

a) An n-bit ring counter sequences through n states. T F

b) An n-bit Johnson counter sequences through n states. T F

c) Row matching method may not be able to find the most-reduced states. T F

d) We can implement sequential circuits without storage elements. T F

e) In a self-starting counter any invalid state eventually transitions to a valid state. T F

f) In the design of finite state machines, different state encodings may lead to circuits with different complexity. T F

g) One-hot encoding usually requires more state bits than sequential binary encoding. T F

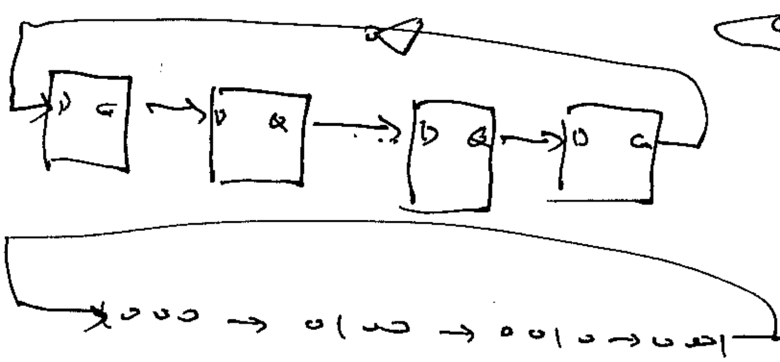
h) In state reduction process, two states are equivalent if they have the same next state behavior. T F

i) For a 4-state finite state machine, if we use two-bit binary encoding, there are totally 24 different encodings. T F

j) In state assignment, we can always find the optimal encoding using heuristic methods.

T F

S_0	S_1	S_2	S_3
00	01	10	11
01	00	10	11
00	01	11	10

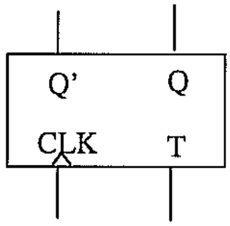


$4! = 4 \times 3 \times 2 \times 1$

$= 24$

2.Implementing a D flipflop using a T flipflop. (15 points)

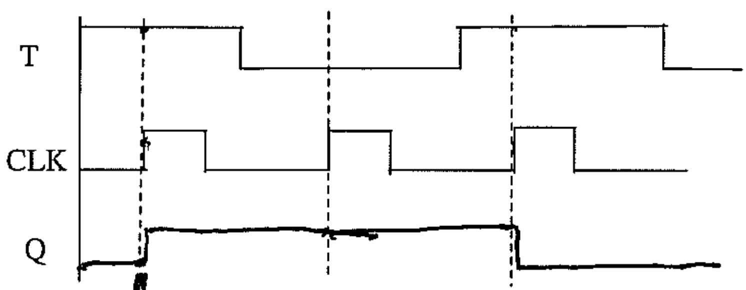
A T flip-flop works as follows: if the input T = 0, the output stays the same; if the input T = 1, the output toggles. In other words, the characteristic equation for the T flip-flop is Q+ = T⊕Q.



a) Complete the following state transition table for the T flip-flop. (5 points)

Input T	Current State Q	Next State Q+
0	0	0
0	1	1
1	0	1
1	1	0

b) Complete the following timing waveform for the T flip-flop. Assuming Q=0 at the beginning. (5 points)

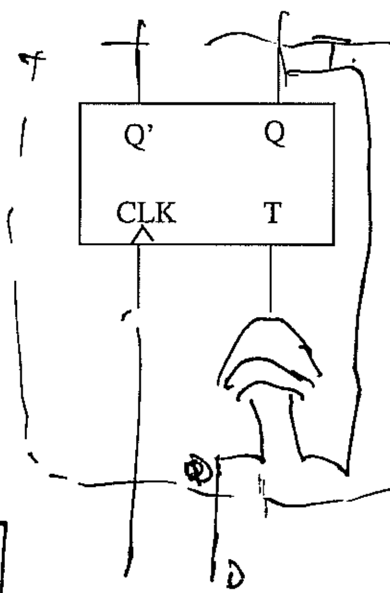


c) Implement a D flip-flop using a T flip-flop. Choose the suitable logic gate(s) you need and draw your circuit below. (5 points)

Q	Q+	D	T
0	0	0	0
0	1	1	1
1	0	0	1
1	1	1	0

$T = f(D\ Q)$

D \ Q	0	1
0		1
1	1	



$T = D \oplus Q$

D:

$Q^+ = D$

$Q^+ = T \oplus Q$

$T = f(D\ Q)$

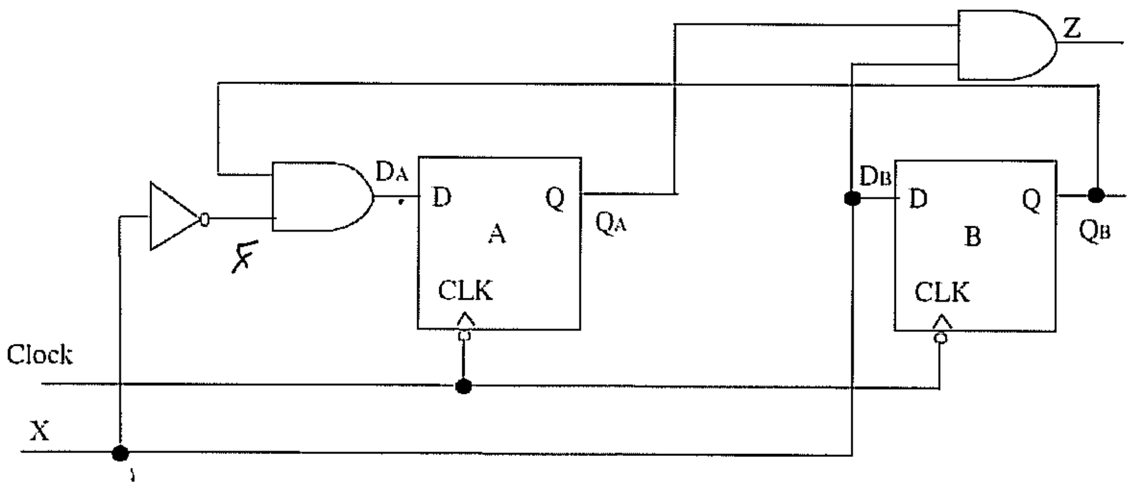
$T = D \oplus Q$

$Q^+ = D \oplus (Q \oplus Q)$

$D \oplus 0 = D$

$\bar{D}Q + D\bar{Q}$

3. Analyzing the following FSM circuit. (30 points)



a) Is this a Moore or Mealy machine? (5 points)

Mealy

b) Obtain the excitation equations for both D flip-flops. (10 points)

$Q_A^+ = D_A = \bar{X} \cdot Q_B$

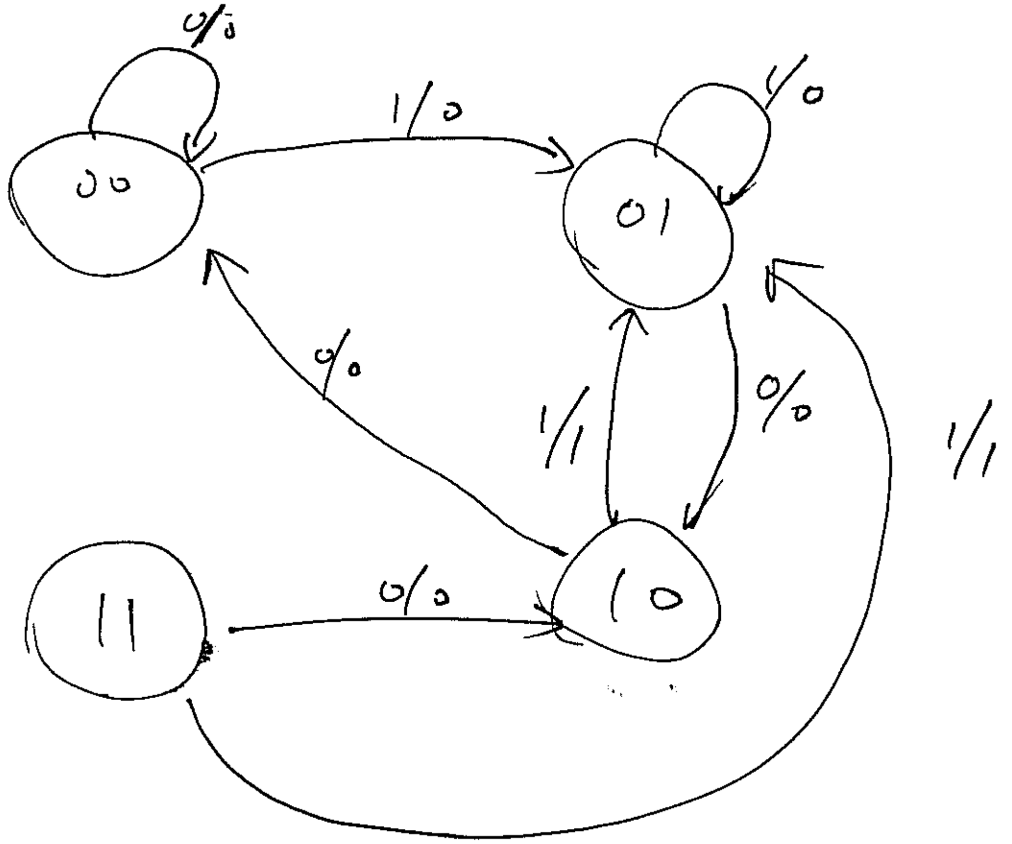
$Q_B^+ = D_B = X$

$Z = Q_A \cdot X$

c) Derive the state transition table (10 points)

Current Q_A Q_B	Next $Q_A^+ Q_B^+$ $X=0$	$X=1$	output Z $X=0$	$X=1$
0 0	0 0	0 1	0	0
0 1	1 0	0 1	0	0
1 0	0 0	0 1	0	1
1 1	1 0	0 1	0	1

d) Draw the state transition diagram (5 points)



4. State encoding. (10 points)

Consider the following symbolic state transition table.

Q	Q+		Z	
	X=0	X=1	X=0	X=1
A	B	C.	1	0
B	A	B	0	0
C	C	C	1	1

1) Is this a Moore machine or a Mealy machine? (5 points)

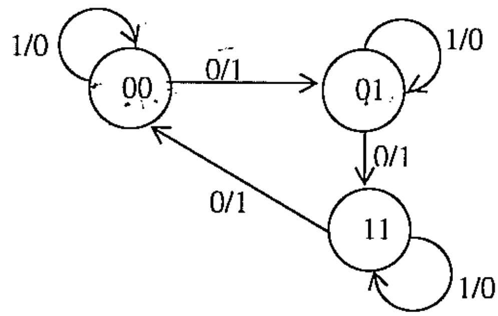
Mealy

2) Complete the state transition table using one-hot encoding. (5 points).

Q	Q+		Z	
	X=0	X=1	X=0	X=1
100	010	001	1	0
010	100	010	0	0
001	001	001	1	1

C B $\boxed{A}$ 100
A A $\boxed{B}$ 010
B C $\boxed{C}$ 001

5. Given the following state transition diagram. (25 points)



a) Derive the state transition table. (10 points)

Current state $Q_1 Q_0$	Next state $Q_1^+ Q_0^+$ $X=0$	$X=1$	output Z $X=0$	$X=1$
0 0	0 1	0 0	1	0
0 1	1 1	0 1	1	0
1 1	0 0	1 1	1	0
1 0	X X	X X	X	X

b) How many flip-flops do you need to implement the finite state machine? (5points)

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c) If we choose D flip flops to implement the above FSM, obtain the excitation equations for the inputs of the D flip-flops and the logic equation for the output. (10 points)

Q_1^+

$X \backslash Q_1Q_0$	00	01	11	10
0	0	1	0	X
1	0	0	1	X

$$Q_1^+ = \overline{X}\,\overline{Q_1}\,Q_0 + XQ_1$$

Q_0^+

$X \backslash Q_1Q_0$	00	01	11	10
0	1	1	0	X
1	0	1	1	X

$$Q_0^+ = XQ_0 + \overline{X}\,\overline{Q_1}$$

Z

$X \backslash Q_1Q_0$	00	01	11	10
0	1	1	1	X
1	0	0	0	X

$$Z = \overline{X}$$