ELEC 2141

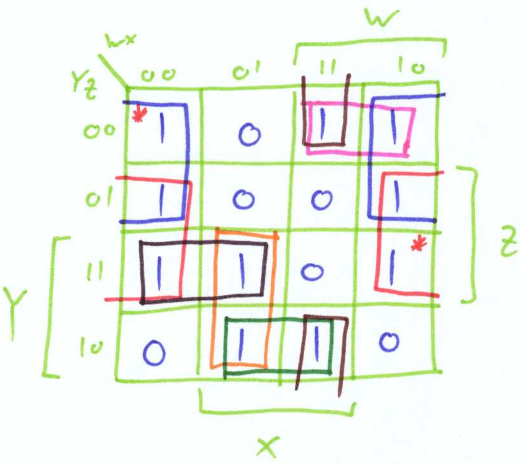
Final Exam, Session 1, 2010

Question 1

i)

$F = \sum m(0, 1, 3, 6, 7, 8, 9, 11, 12, 14)$

1 a)



2 b)

$\bar{X}\bar{Y}$, $\bar{X}Z$, $\bar{W}YZ$, $\bar{W}XY$, $XY\bar{Z}$, $WX\bar{Z}$, $W\bar{Y}\bar{Z}$

2 c)

$\bar{X}\bar{Y}$, $\bar{X}Z$

1 d)

$F = \bar{X}\bar{Y} + \bar{X}Z + \bar{W}XY + WX\bar{Z}$

1 e)

$F = \bar{X}(\bar{Y} + Z) + X(\bar{W}Y + W\bar{Z})$

2 f) GIC = 18.

i)

5

$$A\bar{B}\bar{C} + ABD + \bar{A}BC + \bar{B}C\bar{D}$$

$$= A\bar{B}\bar{C}(\bar{D}+D) + ABD(\bar{C}+C) + \bar{A}BC(\bar{D}+D) + \bar{B}C\bar{D}(\bar{A}+A)$$

$$= \overset{(1)}{A\bar{B}\bar{C}\bar{D}} + \overset{(2)}{A\bar{B}\bar{C}D} + \overset{(2)}{AB\bar{C}D} + \overset{(3)}{ABCD} + \overset{(4)}{\bar{A}BC\bar{D}} + \overset{(3)}{\bar{A}BCD} + \overset{(4)}{\bar{A}\bar{B}C\bar{D}} + \overset{(1)}{A\bar{B}C\bar{D}}$$

$$= A\bar{B}\bar{D}(\bar{C}+C) + A\bar{C}D(\bar{B}+B) + BCD(\bar{A}+A) + \bar{A}C\bar{D}(\bar{B}+B)$$

$$= A\bar{B}\bar{D} + A\bar{C}D + BCD + \bar{A}C\bar{D}.$$

iii)

```
 1 0011 0000 1000 110
   1000 1010 0100 0010
 + 1101 1001 0101 0111
 ---------------------
   0110 0011 1001 1001
```

2 a) 0x6399

2 b) Overflow occured! This is a signed sum, so inspect the V-flag: $V = C_{15} \oplus C_{16} = 0 \oplus 1 = 1$.

iv)

2

Advantage: The final result is available faster.

Disadvantage: Requires many more logic gates.

Question 2

3 i)

C	S	R	Q	/Q	
0	X	X	q	/q	(no change)
1	0	0	q	/q	(no change)
1	0	1	0	1	(reset)
1	1	0	1	0	(set)
1	1	1	1	1	(undefined state)

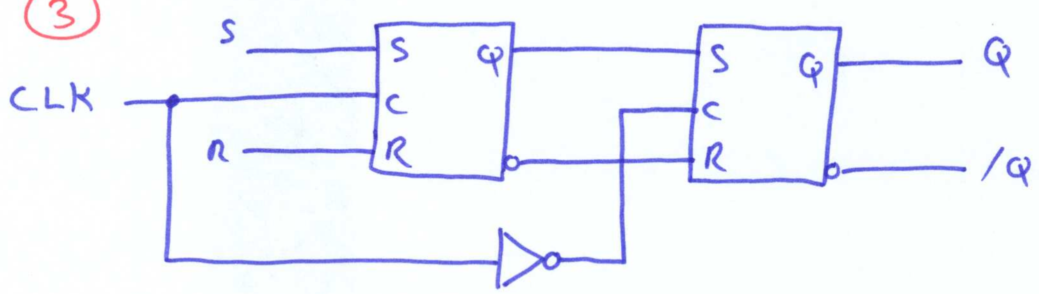
Q - next output

q - current output

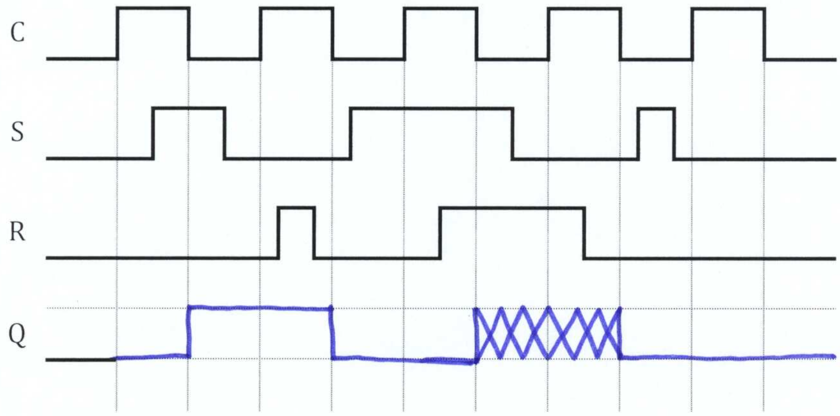
3 ii) Two possibilities: 1. Initially C=S=R=1 and C transits from 1 -> 0. or: 2. Initially C=S=R=1 and both S and R transit 1 -> 0 simultaniously.

This will cause oscillation behavior at the outputs unless one of the feedback paths is longer than the other. In which case, the outputs will settle to one of the possible states but we cannot know which one (unless we know which is the longer path).

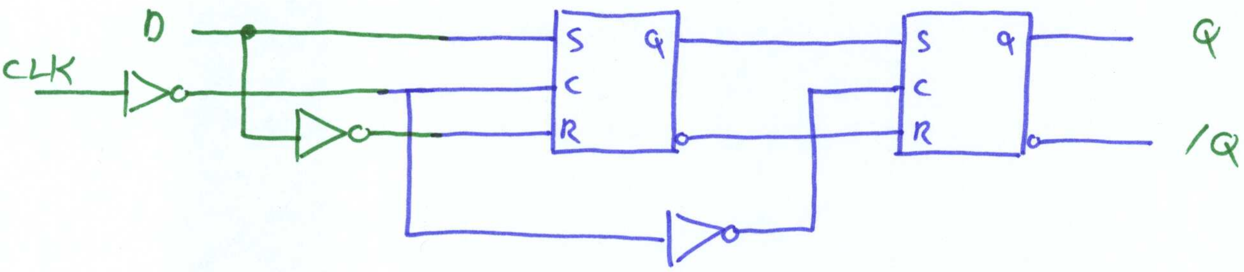
iii) 3



5 iv)



3 v)



3 vi) In the D Flip-Flop, S and R will never be 1 at the same time. Therefore, a race-condition can never occure and we will always be in a known state.

Question 3

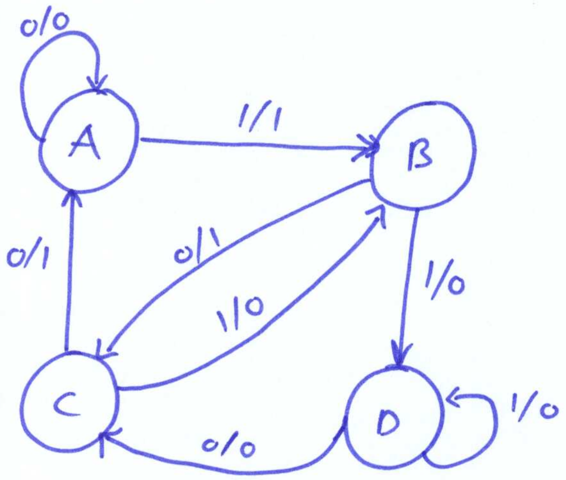
8 i) Define states:

A - Last two bits seen were 00.

B - Last two bits seen were 01.

C - Last two bits seen were 10.

D - Last two bits seen were 11.



This is a Mealy machine.

4 ii)

X		0	1	0	0	1	0	1	1	0	0	1	0
state	A	A	B	C	A	B	C	B	D	C	A	B	C
Z		0	1	1	1	1	1	0	0	0	1	1	1

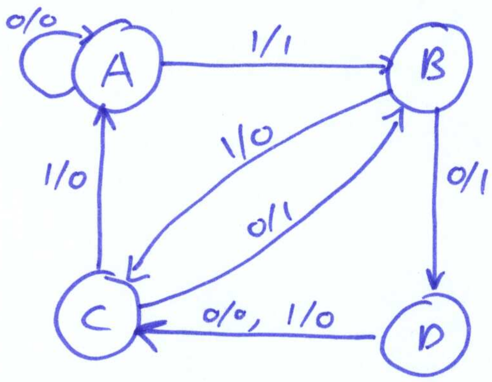
8 iii) Define states:

A - Last two outputs were 00.

B - Last two outputs were 01.

C - Last two outputs were 10.

D - Last two outputs were 11.



Question 4

i)

$$F = \overline{AB + BC + AC}$$

3 a)

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

3 b) PDN: $F = \overline{AB + BC + AC}$

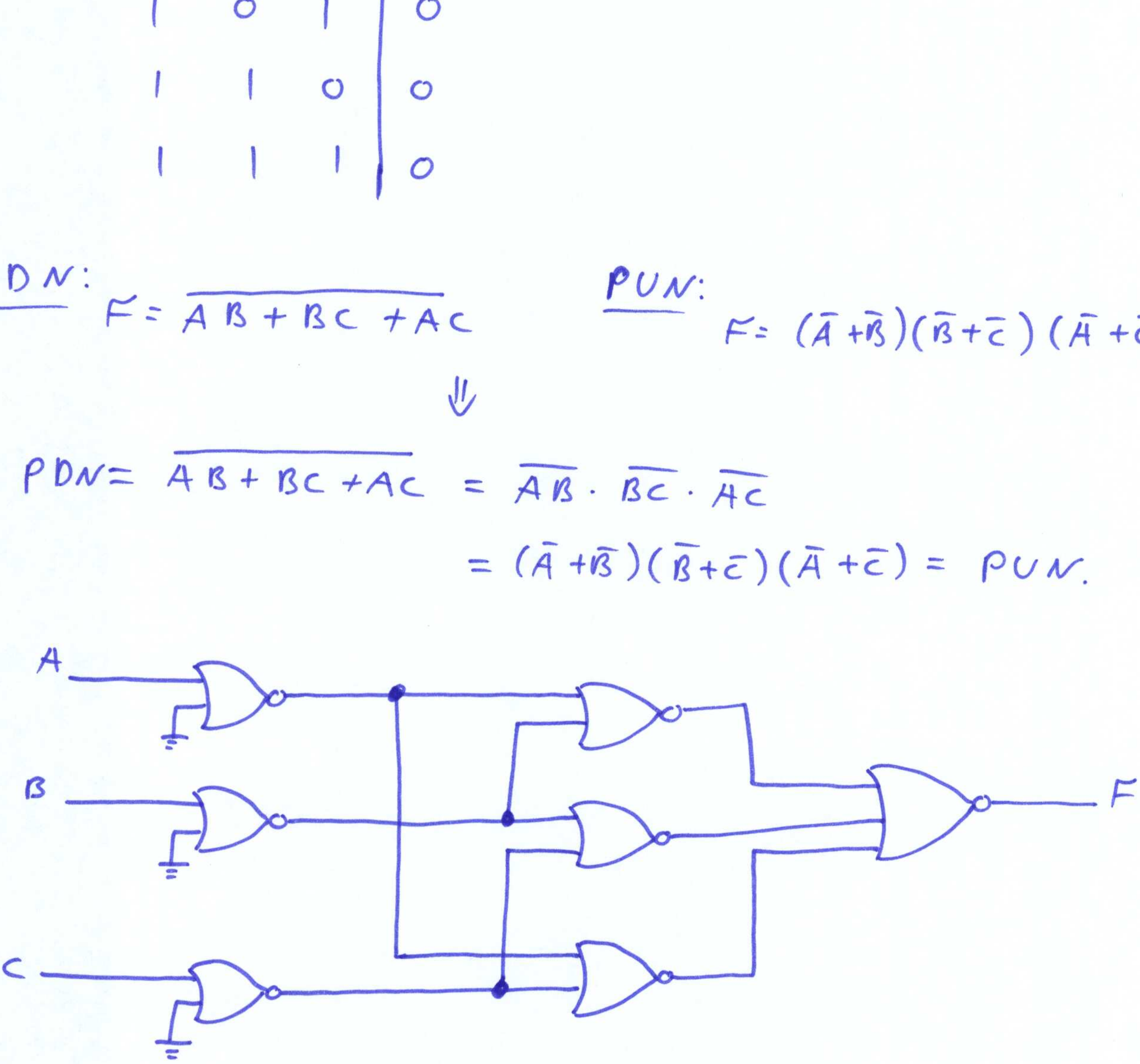
PUN: $F = (\bar{A} + \bar{B})(\bar{B} + \bar{C})(\bar{A} + \bar{C})$

$\Downarrow$

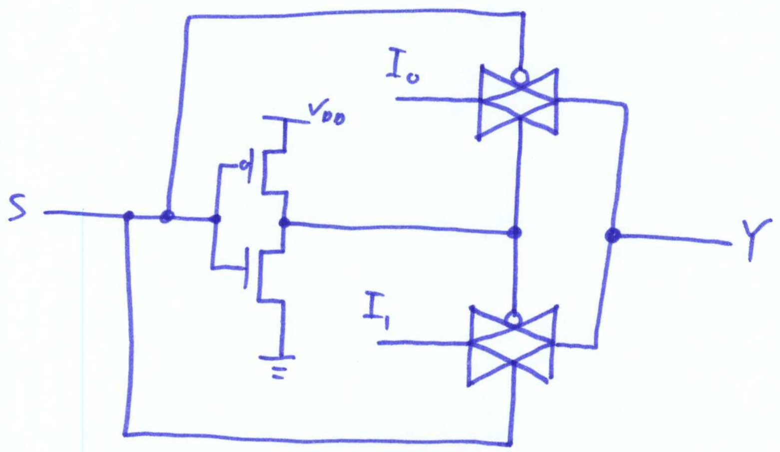
$$PDN = \overline{AB + BC + AC} = \overline{AB} \cdot \overline{BC} \cdot \overline{AC}$$

$$= (\bar{A} + \bar{B})(\bar{B} + \bar{C})(\bar{A} + \bar{C}) = PUN.$$

6 c)

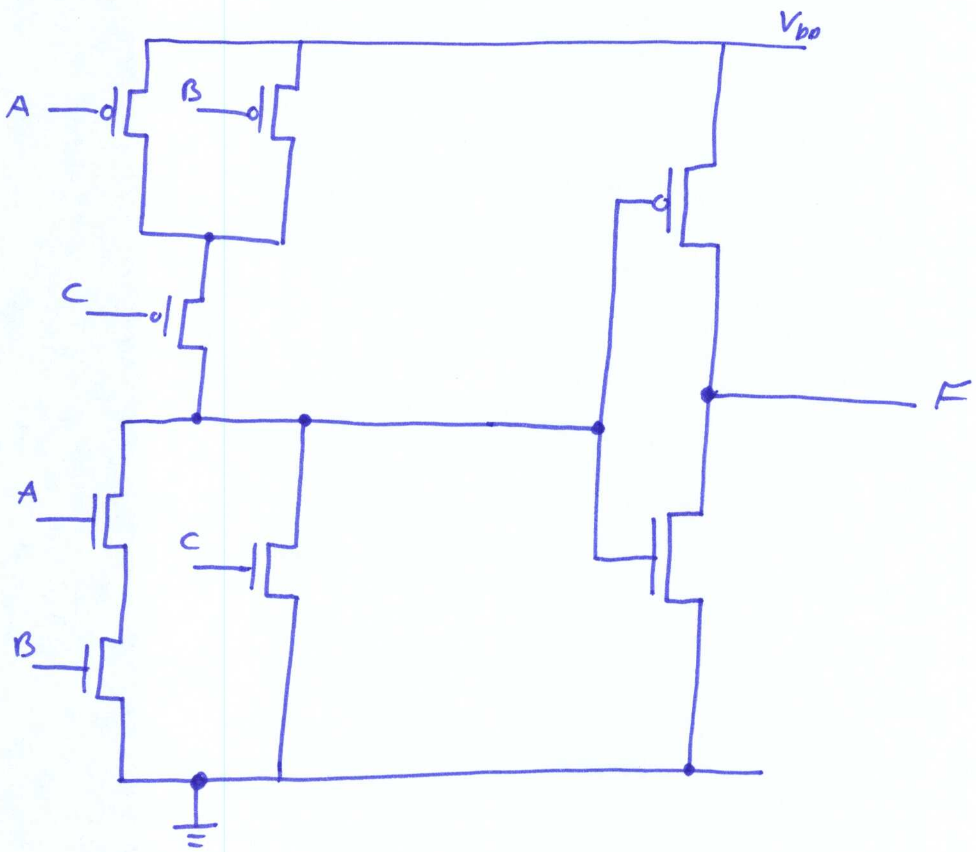


④ ii) 2-to-1-Line Multiplexer:



④ iii)

$F = \overline{AB + C}$



Question 5

① i) The code implements a Moore machine.

④ ii)

current state	next state x=0	next state x=1	output z
A	A	B	0
B	E	D	1
C	D	B	0
D	C	B	0
E	B	F	1
F	E	C	0

⑥ iii)

B	X				
C	A~D B~B	X			
D	A~C B~B	X	C~D B~B		
E	X	~~B~E~~ ~~D~F~~	X	X	
F	~~A~E~~ ~~B~C~~	X	~~D~E~~ ~~B~C~~	~~C~E~~ ~~B~C~~	X
	A	B	C	D	E

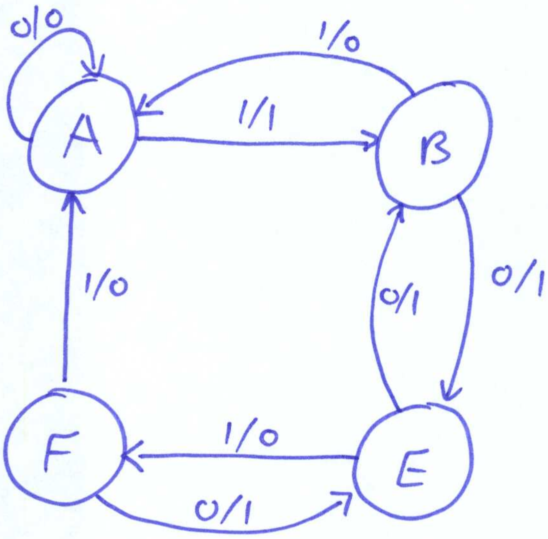
New states:

A ~ C ~ D
B
E
F

Current state	next state x=0	next state x=1	output z
A	A	B	0
B	E	A	1
E	B	F	1
F	E	A	0

6 iv) Mealy Machine:

current state	next state, output x=0	x=1
A	A, 0	B, 1
B	E, 1	A, 0
E	B, 1	F, 0
F	E, 1	A, 0



3 v)

X	1	0	1	0	1	0	0	1	0	0
Z	1	1	0	1	0	1	1	0	0	0