Faculty of Engineering and Technology
Electrical and Computer Engineering Departmen
Advanced Digital Design ENCS533
Homework#5

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Section: 1

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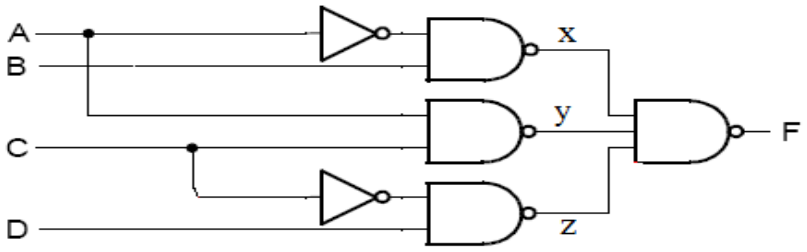
Q1) For the following circuit

i) Determine the values of inputs at which hazard may occur.

ii) Draw the hazard-free circuit (NAND-NAND implementation).



a) $F = \bar{A}.B + A.C + \bar{C}.D$

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

i value of inputs at hazard may occur:

A B C D

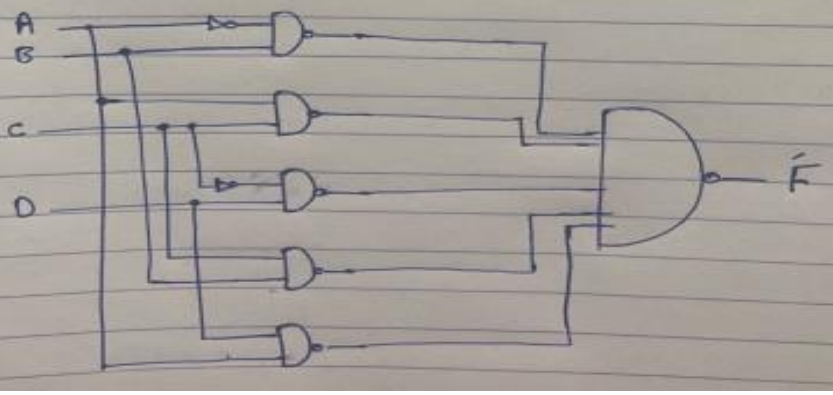
0 1 ⟷ 1 1 1 1

1 0 0 1 ⟷ 1 0 1 1

0 1 1 0 ⟷ 1 1 1 0

0 1 1 1 ⟷ 1 1 1 1

b) new F: $\acute{F} = \bar{A}.B + A.C + \bar{C}.D + A.D + B.C$



Q2) Use asynchronous design procedure to design a positive edge TFF that has 2 inputs T and CLK, and one output Q. Use SR Latches in your design.

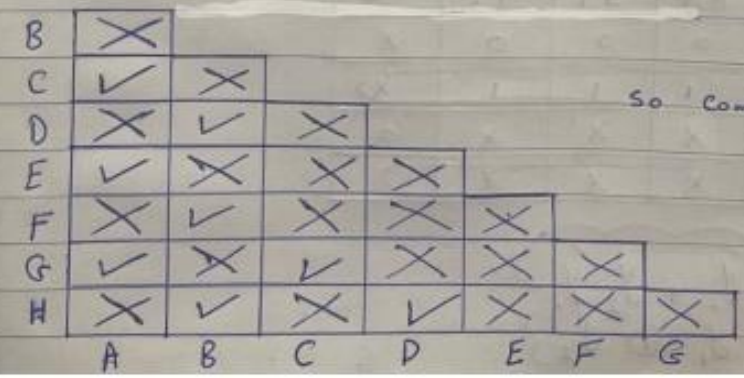
*

	T	clk	Q	Stable	Note
A	0	0	0	✓	after C, E
B	0	0	1	✓	after D, F
C	0	1	0	✓	after G, A
D	0	1	1	✓	after B, H
E	1	0	0	✓	after A, G
F	1	0	1	✓	after B, H
G	1	1	0	✓	after C, F
H	1	1	1	✓	after D, E

* Primitive flow table :

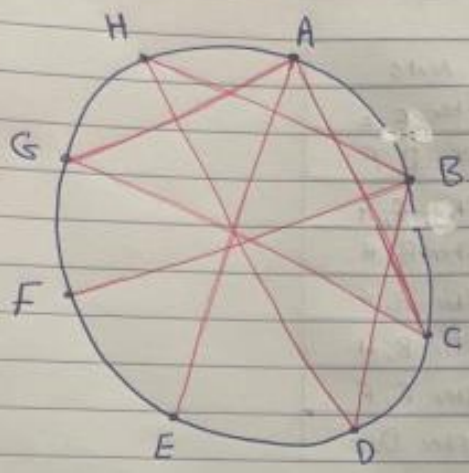
	00	01	11	10
A	(A), 0	C, –	–, –	E, –
B	(B), 1	D, –	–, –	F, –
C	A, –	(C), 0	G, –	–, –
D	B, –	(D), 1	H, –	–, –
E	A, –	–, –	H, –	(E), 0
F	B, –	–, –	G, –	(F), 1
G	–, –	C, –	(G), 0	E, –
H	–, –	D, –	(H), 1	F, –

* Implication chart:



So compatable pairs is
(A, C), (A, E)
(A, G), (B, D)
(B, F), (B, H)
(C, G), (D, H)

* Merger diagram



* Max compatable pars:

(A, C, G) → (A, C, G)
(B, D, H) → (B, D, H)
(A, E) → (E)
(B, F) → (F)

	00	01	11	10
A,C,G	A,0	C,0	G,0	E,-
B,D,H	B,1	D,1	H,1	F,-
E	A,-	-,-	H,-	E,0
F	B,-	-,-	G,-	F,1

note:
A, C, G → A
B, D, H → B
E → C
F → D

	00	01	11	10
A	A,0	A,0	A,0	C,-
B	B,1	B,1	B,1	D,-
C	A,-	-,-	B,-	C,0
D	B,-	-,-	A,-	D,1

y_1y_2	00	01	11	10
00	00	00	00	11
01	01	01	01	10
11	00	XX	01	11
10	01	XX	00	10

y_1y_2	00	01	11	10
00	0	0	0	X
01	1	1	1	X
11	X	X	X	0
10	X	X	X	1

$$Q = y_1\bar{y}_2 + y_2\bar{y}_1$$
$$= y_1 \oplus y_2$$

* SR Latch Table

y_1 :

y_1y_2 \ T,C	00	01	11	10
00	0	0	0	1
01	0	0	0	1
11	0	X	0	1
10	0	X	0	1

y_1y_2 \ T,C	00	01	11	10
00	0	0	0	1
01	0	0	0	1
11	0	X	0	X
10	0	X	0	X

y_1y_2 \ T,C	00	01	11	10
00	X	X	X	0
01	X	X	X	0
11	1	X	1	0
10	1	X	1	0

$S = T \cdot \overline{C}$

$R = \overline{T} + C$

y_2 :

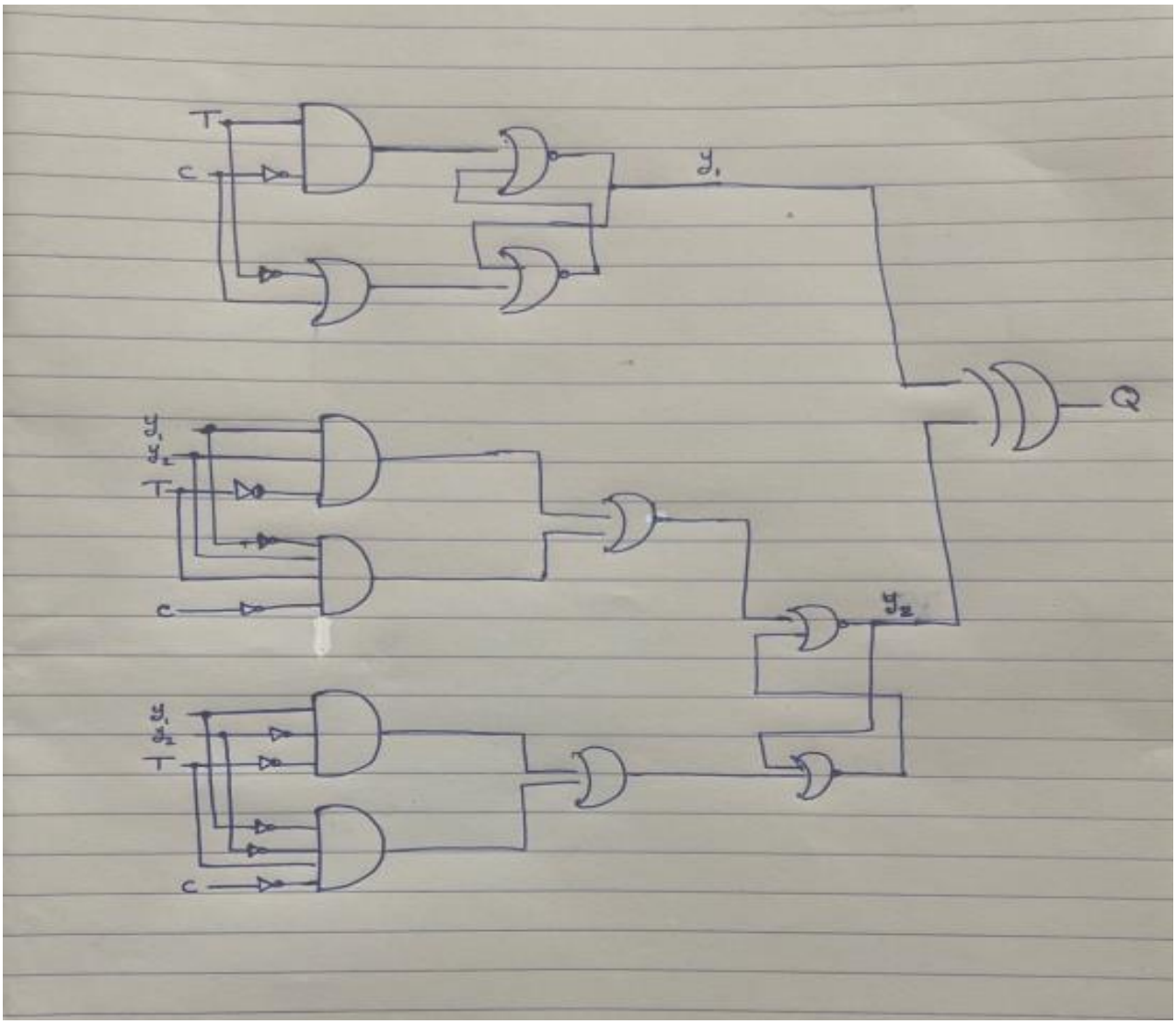
y_1y_2 \ T,C	00	01	11	10
00	0	0	0	1
01	1	1	1	0
11	0	X	1	1
10	1	X	0	0

y_1y_2 \ T,C	00	01	11	10
00	0	0	0	1
01	X	X	X	0
11	0	X	X	X
10	1	X	0	0

y_1y_2 \ T,C	00	01	11	10
00	X	X	X	0
01	0	0	0	1
11	1	X	0	0
10	0	X	X	X

$S = y_1 \cdot \overline{y}_2 \cdot \overline{T} + \overline{y}_1 \cdot \overline{y}_2 \cdot T \cdot \overline{C}$

$R = y_1 \cdot y_2 \cdot \overline{T} + \overline{y}_1 \cdot y_2 \cdot T \cdot \overline{C}$


T
C
y_1
Q
y_1
y_2
T
C
y_2
y_1
y_2
T
C