

## EE1005 – Digital Logic Design

### Quiz# 5 (CS – 2F)

#### Solution Manual

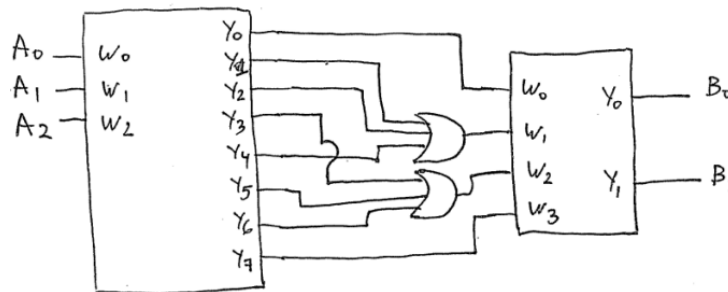
**Question 1:** Design a circuit that takes a 3-bit binary input and outputs a 2-bit binary number representing the count of '1's in the input. Use a 3-to-8 decoder, OR gates, and a 4-to-2 encoder for implementation. [5 marks]

#### Solution

##### Truth Table:

A2	A1	A0	Number of 1's	B1	B0
0	0	0	0	0	0
0	0	1	1	0	1
0	1	0	1	0	1
0	1	1	2	1	0
1	0	0	1	0	1
1	0	1	2	1	0
1	1	0	2	1	0
1	1	1	3	1	1

##### Design Implementation:



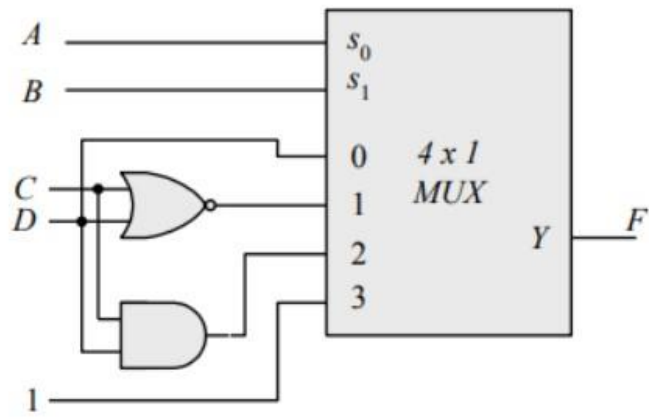
**Question 2:** Implement the following Boolean function with 4X1 MUX and external gates where AB are select lines and C D are data lines.

a)  $F(A,B,C,D) = \sum(1,3,4,11,12,13,14,15)$

b)  $F(A,B,C,D) = \sum(1,2,5,7,8,10,11,13,15)$

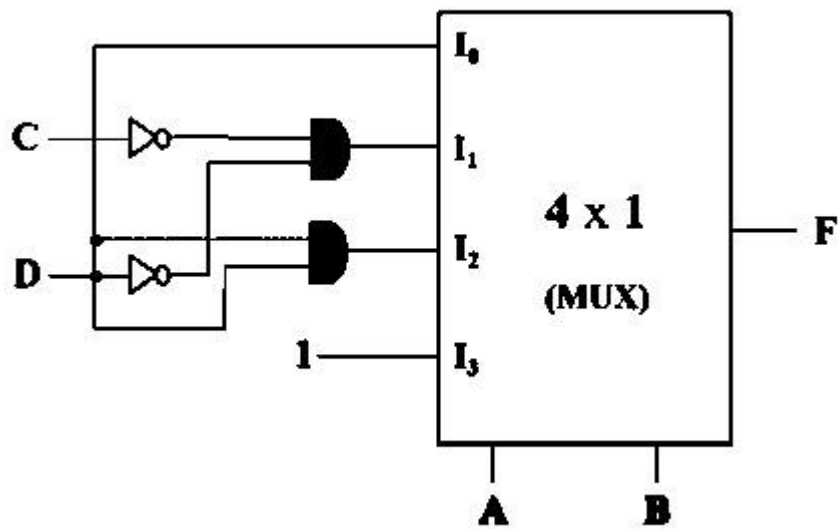
##### Solution:

Inputs <i>ABCD</i>	<i>F</i>
0000	0
0001	1 $AB = 00$
0010	0 $F = D$
0011	1
0100	1 $AB = 01$
0101	0 $F = C'D'$
0110	0 $= (C + D)'$
0111	0
1000	0
1001	0 $AB = 10$
1010	0 $F = CD$
1011	1
1100	1 $AB = 11$
1101	1 $F = 1$
1110	1
1111	1



OR

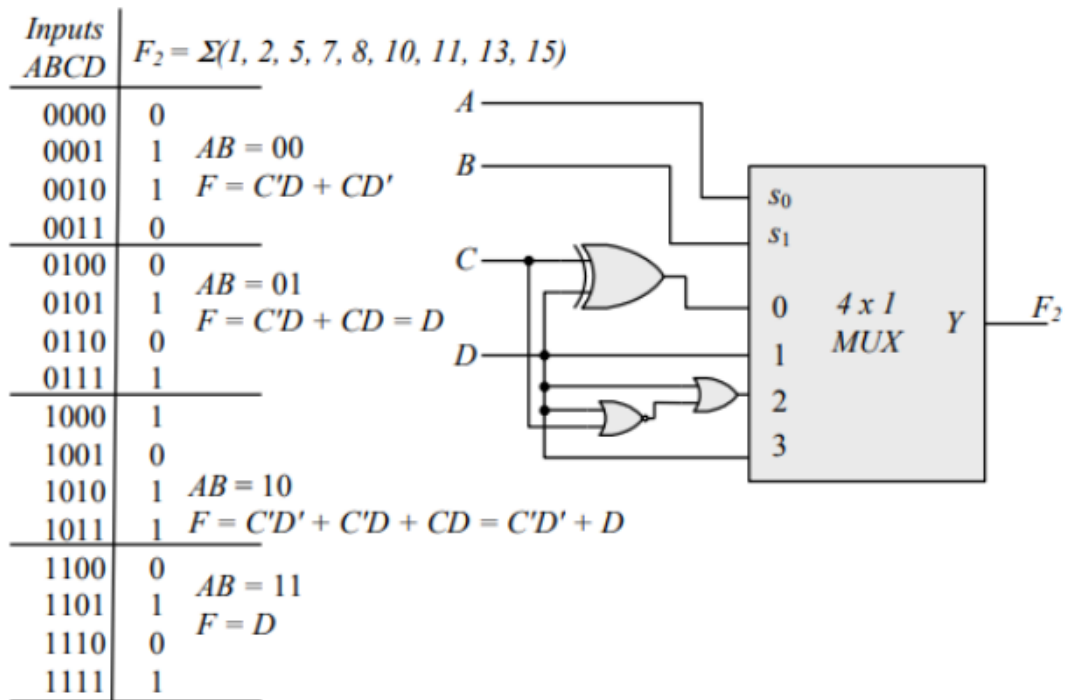
		A	B	C	D	F					
$I_0$	<table><tr><td>A</td><td>B</td></tr><tr><td>0</td><td>0</td></tr></table>	A	B	0	0	0	0	0	0	0	$F = D$
	A	B									
	0	0									
		0	0	0	1	1					
	0	0	1	0	0						
	0	0	1	1	1						
$I_1$	<table><tr><td>0</td><td>1</td></tr></table>	0	1	0	1	0	0	1	$F = C'D'$		
	0	1									
		0	1	0	1	0					
		0	1	1	0	0					
	0	1	1	1	0						
$I_2$	<table><tr><td>1</td><td>0</td></tr></table>	1	0	1	0	0	0	0	$F = CD$		
	1	0									
		1	0	0	1	0					
		1	0	1	0	0					
	1	0	1	1	1						
$I_3$	<table><tr><td>1</td><td>1</td></tr></table>	1	1	1	1	0	0	1	$F = 1$		
	1	1									
		1	1	0	1	1					
		1	1	1	0	1					
	1	1	1	1	1						



b)

**SOLUTION:**

$$F = \Sigma(1, 2, 5, 7, 8, 10, 11, 13, 15)$$



**Question 3: Design a combinational circuit with a decoder to accept a 3-bit number and generate the output binary number equal to the square of the input number. Implement this using 2:4 decoder.**

**Solution:**

A2	A1	A0	Decimal Input	Y5	Y4	Y3	Y2	Y1	Y0
0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	0	0	1
0	1	0	2	0	0	0	1	0	0
0	1	1	3	0	0	1	0	0	1
1	0	0	4	0	1	0	0	0	0
1	0	1	5	0	1	1	0	0	1
1	1	0	6	1	0	0	1	0	0
1	1	1	7	1	1	0	0	0	1

**Equations:**

$$Y_0 = C$$

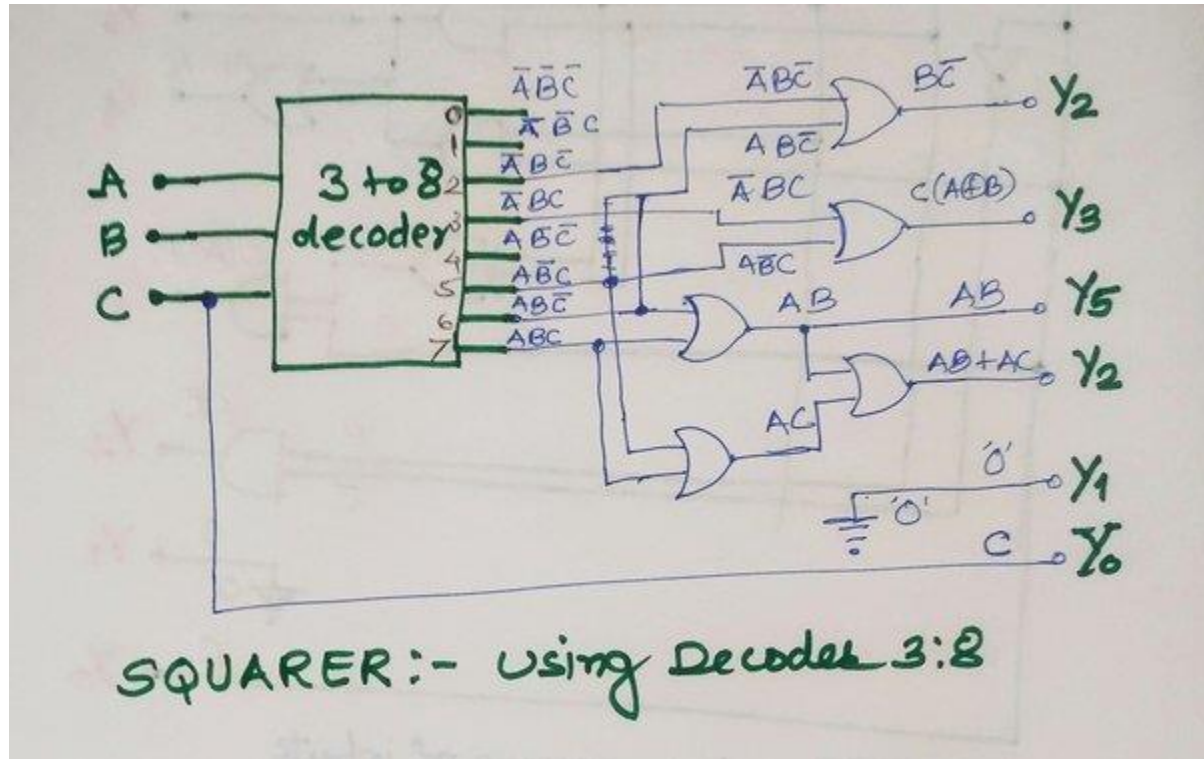
$$Y_1 = 0$$

$$Y_2 = BC'$$

$$Y_3 = A'BC + AB'C = C(A \oplus B)$$

$$Y_4 = AB' + AC$$

$$Y_5 = AB$$



**Question 4:** A sequential circuit with two D flip-flops A and B, two inputs, x and y ; and one output z is specified by the following next-state and output equations.

**[15 Marks]**

$$A(t+1) = xy' + xB$$

$$B(t+1) = xA + xB'$$

$$z = A$$

Implement the following

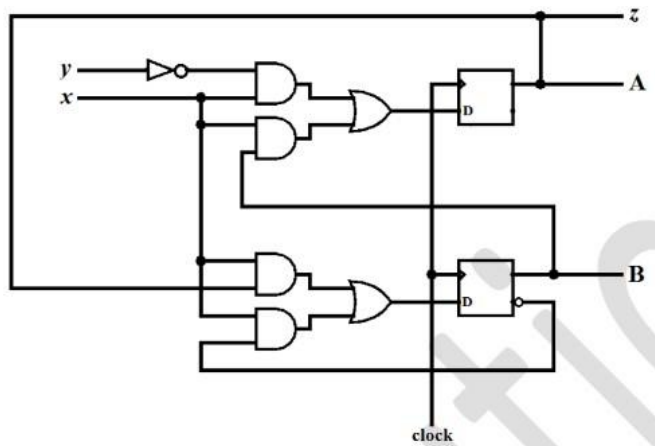
- Draw the logic diagram of the circuit.
- List the state table for the sequential circuit.
- Draw the corresponding state diagram.

**5 marks**

**6 marks**

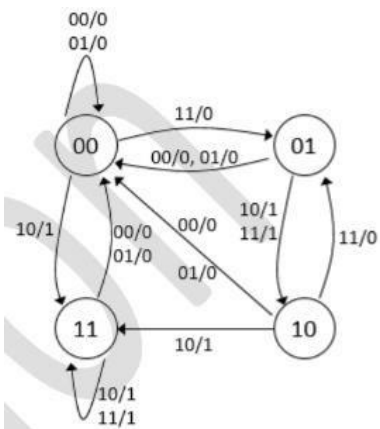
**4 marks**

**Solution:**



Present State		Inputs						Next State		Output
A	B	x	y	$xy'$	$xB$	$xA$	$xB'$	A	B	z
0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1	1	1	1
0	0	1	1	0	0	0	1	0	1	0
0	1	0	0	0	0	0	0	0	0	0
0	1	0	1	0	0	0	0	0	0	0
0	1	1	0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0	1	0	1
1	0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0	0	0
1	0	1	0	1	0	1	1	1	1	1
1	0	1	1	0	0	1	1	0	1	0
1	1	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	0
1	1	1	0	1	1	1	0	1	1	1
1	1	1	1	0	1	1	0	1	1	1

For Learning purpose: <https://www.youtube.com/watch?v=bq65gCzDNhA>

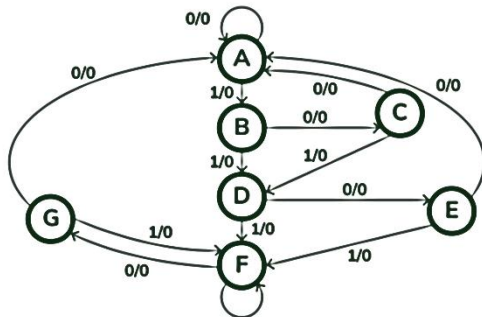


**Question 5:** Given the following state diagram, perform the following tasks: **[5+5+5=15 marks]**

a) Construct the state table that corresponds to the given state diagram.

b) Reduce the state table to its minimized form step by step.

c) Draw the reduced state diagram



a)

Present state	Next state		Output	
	X=0	X=1	X=0	X=1
a	a	b	0	0
b	c	d	0	0
c	a	d	0	0
d	e	f	0	1
e	a	f	0	1
f	g	f	0	1
g	a	f	0	1

b)

**Step1:** eliminate the g state in the state table and wherever g is present replace it with e. Because e and g both are the same i.e. e=g.

Present state	Next state		Output	
	X=0	X=1	X=0	X=1
a	a	b	0	0
b	c	d	0	0
c	a	d	0	0
d	e	f	0	1
e	a	f	0	1
f	e(g=e)	f	0	1

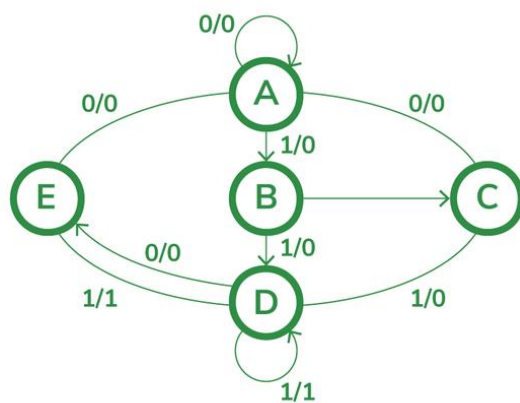
**Step 2:**

Here d and f are having the same next state value and output. So eliminate f and wherever f is present replace it with d. Because both are the same d=f

Present state	Next state		Output	
	X=0	X=1	X=0	X=1
a	a	b	0	0
b	c	d	0	0
c	a	d	0	0
d	e	d(d=f)	0	1
e	a	d(d=f)	0	1

**Step 3:** Further observe if any similar states are present or not. The states c and e are having same next states but they are having different outputs. So we cannot consider it a reduction state.

c)



### **BONUS TASK:**

#### **Puzzle:**

In a car race, Alex finishes before Ben and Carl, but behind Dave. Ben finishes before Carl but behind Emma. Who finishes the race first?

#### **Answer:**

From the clues:

- Alex finishes before Ben and Carl but behind Dave.
- Ben finishes before Carl but behind Emma.

Ordering the racers:

- Dave finishes before Alex (from the first clue).
- Alex finishes before Ben and Carl.
- Emma finishes before Ben (from the second clue).

Thus, the order must be: Dave, Emma, Alex, Ben, Carl.

**So, Dave finishes the race first.**