ASSIGNMENT 1 (DIGITAL LOGIC AND CIRCUITS)

QUESTION a))

Minterm = 0,1,3,8,9,13,14,15,16,17,19,24,25,27,31
DontCare = NONE
Variable = A,B,C,D,E
using Quine-McCluskey

INPUT EXPRESSION: Y = A'B'C'D'E' + A'B'C'D'E + A'B'C'DE + A'BC'D'E'
+ A'BC'D'E + A'BCD'E + A'BCDE' + A'BCDE
+ AB'C'D'E' + AB'C'D'E + AB'C'DE + ABC'D'E'
+ ABC'D'E + ABC'DE + ABCDE

Solution:

$$F(A,B,C,D,E) = \sum m(0,1,3,8,9,13,14,15,16,17,19,24,25,27,31)$$

Variables = A,B,C,D,E
1. min terms and their binary representations
Considering the number of ones .

Group G1	0	00000	***
Group G2	1	00001	***
	8	01000	***
	16	10000	***
Group G3	3	00011	***
	9	01001	***
	17	10001	***
	24	11000	***
Group G4	13	01101	***
	14	01110	***
	19	10011	***
	25	11001	***
Group G5	15	01111	***
	27	11011	***
Group G6	31	11111	***

2. merging of min term

Group H1 (G1,G2)	0,1	0000-	***
	0,8	0-000	***
	0,16	-0000	***
Group H2 (G2,G3)	1,3	000-1	***
	1,9	0-001	***
	1,17	-0001	***
	8,9	0100-	***
	8,24	-1000	***
	16,17	1000-	***
	16,24	1-000	***
Group H3 (G3,G4)	3,19	-0011	***
	9,13	01-01	?
	9,25	-1001	***
	17,19	100-1	***
	17,25	1-001	***
	24,25	1100-	***
Group H4 (G4,G5)	13,15	011-1	?
	14,15	0111-	?
	19,27	1-011	***
	25,27	110-1	***
Group H5 (G5,G6)	15,31	-1111	?
	27,31	11-11	?

3. merging of min term pairs

Group J1 (H1,H2)	0,1,8,9	0-00-	***
	0,1,16,17	-000-	***
	0,8,16,24	--000	***
Group J2 (H2,H3)	1,3,17,19	-00-1	?
	1,9,17,25	--001	***
	8,9,24,25	-100-	***
	16,17,24,25	1-00-	***
Group J3 (H3,H4)	17,19,25,27	1-0-1	?

4. merging of min term pairs

Group K1 (J1,J2)	0,1,8,9,16,17,24,25	--00- ?

1. Prime implicant chart

PIs\Minterms	0	1	3	8	9	13	14	15	16	17	19	24	25	27	31	A,B,C,D,E
9,13					X	X										01-01
13,15						X		X								011-1
14,15							X	X								0111-
15,31								X							X	-1111
27,31														X	X	11-11
1,3,17,19		X	X							X	X					-00-1
17,19,25,27										X	X		X	X		1-0-1
0,1,8,9,16,17,24,25	X	X		X	X				X	X		X	X			--00-

Extracted essential prime implicants : --00-,-00-1,0111-

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2. Reduced Prime implicant chart

PIs\Minterms	13	27	31	A,B,C,D,E
9,13	X			01-01
13,15	X			011-1
15,31			X	-1111
27,31		X	X	11-11
17,19,25,27		X		1-0-1

Extracted essential prime implicants : 11-11

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3. Reduced Prime implicant chart

PIs\Minterms	13	A,B,C,D,E
9,13	X	01-01
13,15	X	011-1
15,31		-1111
17,19,25,27		1-0-1

Extracted essential prime implicants : 01-01

All extracted essential prime implicants : --00-, -00-1, 0111-, 11-11, 01-01

Minimal QuineMcCluskey Expression = C'D' + B'C'E + A'BCD + ABDE + A'BD'E

TRUTH TABLE OF OUTPUT MINIMIZED EXPRESSION:

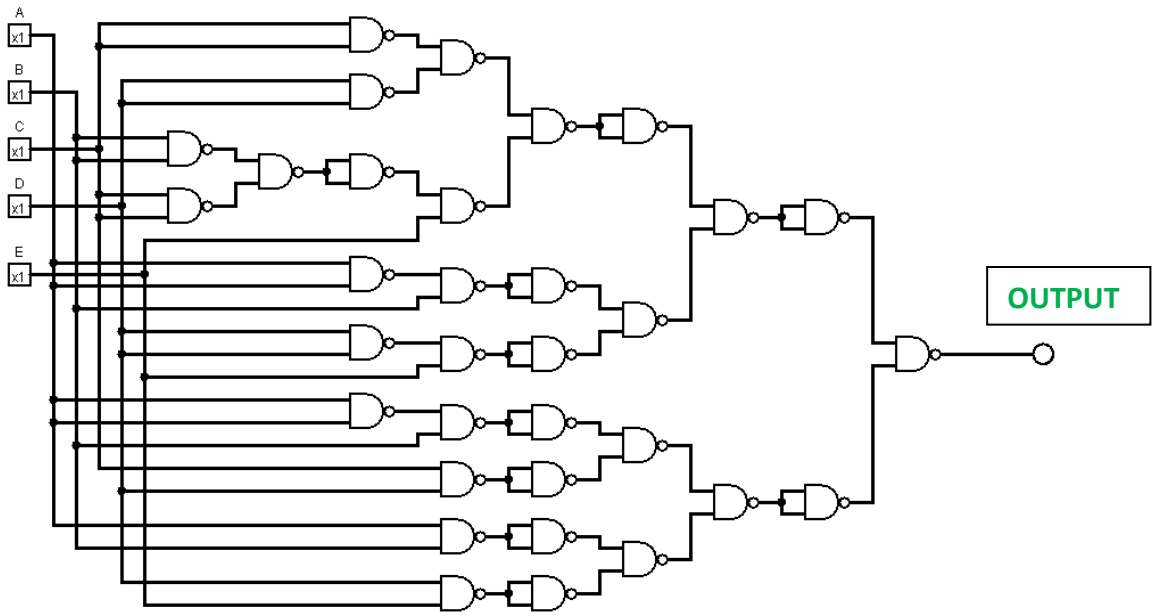
A	B	C	D	E	Y = C'D' + B'C'E + A'BCD + ABDE + A'BD'E
0	0	0	0	0	1
0	0	0	0	1	1
0	0	0	1	0	0
0	0	0	1	1	1
0	0	1	0	0	0
0	0	1	0	1	0
0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	0	1	1
0	1	0	1	0	0
0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	1
0	1	1	1	0	1
0	1	1	1	1	1
1	0	0	0	0	1
1	0	0	0	1	1
1	0	0	1	0	0
1	0	0	1	1	1
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	0	1	1
1	1	0	1	0	0
1	1	0	1	1	1
1	1	1	0	0	0
1	1	1	0	1	0
1	1	1	1	0	0
1	1	1	1	1	1

TRUTH TABLE OF INPUT EXPRESSION:

A	B	C	D	E	Y = A’B’C’D’E’ + A’B’C’D’E + A’B’C’DE + A’BC’D’E’ + A’BC’D’E + A’BCD’E + A’BCDE’ + A’BCDE + AB’C’D’E’ + AB’C’D’E + AB’C’DE + ABC’D’E’ + ABC’D’E + ABC’DE + ABCDE
0	0	0	0	0	1
0	0	0	0	1	1
0	0	0	1	0	0
0	0	0	1	1	1
0	0	1	0	0	0

0	0	1	0	1	0
0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	0	1	1
0	1	0	1	0	0
0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	1
0	1	1	1	0	1
0	1	1	1	1	1
1	0	0	0	0	1
1	0	0	0	1	1
1	0	0	1	0	0
1	0	0	1	1	1
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	0	1	1
1	1	0	1	0	0
1	1	0	1	1	1
1	1	1	0	0	0
1	1	1	0	1	0
1	1	1	1	0	0
1	1	1	1	1	1

MINIMIZED CIRCUIT WITH TWO INPUT NAND GATE:



QUESTION b))

Minterm = 0,1,3,8,9,13,14,15,16,17,19,24,25,27,31
DontCare = 5,7,15,18,26
Variable = A,B,C,D,E
using Quine-McCluskey

Solution:

Minterm = $\sum m(0,1,3,8,9,13,14,15,16,17,19,24,25,27,31)$

Variable = A,B,C,D,E

Dontcare = $\sum d(5,7,15,18,26)$

F(A,B,C,D,E) = $\sum m(0,1,3,8,9,13,14,15,16,17,19,24,25,27,31) + \sum d(5,7,15,18,26)$

As Max of Minterm is 31, So we have taken N = 5
and Variable = A,B,C,D,E
1. min terms and their binary representations

Group G1		0	00000	***
Group G2		1	00001	***
		8	01000	***
		16	10000	***
Group G3		3	00011	***
		9	01001	***
		17	10001	***
		24	11000	***
		5	00101	***
		18	10010	***

Group G4		13	01101	***
		14	01110	***
		19	10011	***
		25	11001	***
		7	00111	***
		26	11010	***
Group G5		15	01111	***
		27	11011	***
Group G6		31	11111	***

2. merging of min term

Group H1 (G1,G2)		0,1	0000-	***
		0,8	0-000	***
		0,16	-0000	***
Group H2 (G2,G3)		1,3	000-1	***
		1,9	0-001	***
		1,17	-0001	***
		1,5	00-01	***
		8,9	0100-	***
		8,24	-1000	***
		16,17	1000-	***
		16,24	1-000	***
		16,18	100-0	***
Group H3 (G3,G4)		3,19	-0011	***
		3,7	00-11	***
		9,13	01-01	***
		9,25	-1001	***
		17,19	100-1	***
		17,25	1-001	***
		24,25	1100-	***
		24,26	110-0	***
		5,13	0-101	***
		5,7	001-1	***
		18,19	1001-	***
		18,26	1-010	***
Group H4 (G4,G5)		13,15	011-1	***
		14,15	0111-	?
		19,27	1-011	***
		25,27	110-1	***
		7,15	0-111	***
		26,27	1101-	***
Group H5 (G5,G6)		15,31	-1111	?

		27,31	11-11	?

3. merging of min term pairs

Group J1 (H1,H2)		0,1,8,9	0-00-	***
		0,1,16,17	-000-	***
		0,8,16,24	--000	***
Group J2 (H2,H3)		1,5,9,13	0--01	?
		1,3,17,19	-00-1	?
		1,9,17,25	--001	***
		1,3,5,7	00--1	?
		8,9,24,25	-100-	***
		16,17,24,25	1-00-	***
		16,18,24,26	1-0-0	***
		16,17,18,19	100--	***
Group J3 (H3,H4)		17,19,25,27	1-0-1	***
		24,25,26,27	110--	***
		5,7,13,15	0-1-1	?
		18,19,26,27	1-01-	***

4. merging of min term pairs

Group K1 (J1,J2)		0,1,8,9,16,17,24,25	--00-	?
Group K2 (J2,J3)		16,17,18,19,24,25,26,27	1-0--	?

1. Prime implicant chart

PIs\Minterms	**0**	**1**	**3**	**8**	**9**	**13**	**14**	**15**	**16**	**17**	**19**	**24**	**25**	**27**	**31**	**A,B,C,D,E**
14,15							X	X								0111-
15,31								X							X	-1111
27,31														X	X	11-11
1,5,9,13		X			X	X										0--01
1,3,17,19		X	X							X	X					-00-1
1,3,5,7		X	X													00--1
5,7,13,15						X		X								0-1-1
0,1,8,9,16,17,24,25	X	X		X	X				X	X		X	X			--00-
16,17,18,19,24,25,26,27									X	X	X	X	X	X		1-0--

Extracted essential prime implicants : --00-,0111-

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2. Reduced Prime implicant chart

PIs\Minterms	**3**	**13**	**19**	**27**	**31**	**A,B,C,D,E**
15,31					X	-1111
27,31				X	X	11-11

1,5,9,13		X				0--01
1,3,17,19	X		X			-00-1
1,3,5,7	X					00--1
5,7,13,15		X				0-1-1
16,17,18,19,24,25,26,27			X	X		1-0--

Extracted essential prime implicants : 11-11

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3. Reduced Prime implicant chart

PIs\Minterms	3	13	19	A,B,C,D,E
15,31				-1111
1,5,9,13		X		0--01
1,3,17,19	X		X	-00-1
1,3,5,7	X			00--1
5,7,13,15		X		0-1-1
16,17,18,19,24,25,26,27			X	1-0--

Extracted essential prime implicants : -00-1

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4. Reduced Prime implicant chart

PIs\Minterms	13	A,B,C,D,E
15,31		-1111
1,5,9,13	X	0--01
1,3,5,7		00--1
5,7,13,15	X	0-1-1
16,17,18,19,24,25,26,27		1-0--

Extracted essential prime implicants : 0--01

All extracted essential prime implicants : --00-,0111-,11-11,-00-1,0—01

Minimal QuineMcCluskey Expression = C'D' + A'BCD + ABDE + B'C'E + A'D'E

OUTPUT EXPRESSION TRUTH TABLE:

A	B	C	D	E	Y = C'D' + A'BCD + ABDE + B'C'E + A'D'E
0	0	0	0	0	1
0	0	0	0	1	1
0	0	0	1	0	0
0	0	0	1	1	1
0	0	1	0	0	0
0	0	1	0	1	1

0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	0	1	1
0	1	0	1	0	0
0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	1
0	1	1	1	0	1
0	1	1	1	1	1
1	0	0	0	0	1
1	0	0	0	1	1
1	0	0	1	0	0
1	0	0	1	1	1
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	0	1	1
1	1	0	1	0	0
1	1	0	1	1	1
1	1	1	0	0	0
1	1	1	0	1	0
1	1	1	1	0	0
1	1	1	1	1	1

INPUT EXPRESSION TRUTH TABLE:

A	B	C	D	E	Y = A'B'C'D'E' + A'B'C'D'E + A'B'C'DE + A'BC'D'E' + A'BC'D'E + A'BCD'E + A'BCDE' + A'BCDE + AB'C'D'E' + AB'C'D'E + AB'C'DE + ABC'D'E' + ABC'D'E + ABC'DE + ABCDE (Don't Cares: 5,7,15,18,26)
0	0	0	0	0	1
0	0	0	0	1	1
0	0	0	1	0	0
0	0	0	1	1	1
0	0	1	0	0	0
0	0	1	0	1	1
0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	0	1	1
0	1	0	1	0	0

0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	1
0	1	1	1	0	1
0	1	1	1	1	1
1	0	0	0	0	1
1	0	0	0	1	1
1	0	0	1	0	0
1	0	0	1	1	1
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	0	1	1
1	1	0	1	0	0
1	1	0	1	1	1
1	1	1	0	0	0
1	1	1	0	1	0
1	1	1	1	0	0
1	1	1	1	1	1

MINIMIZED CIRCUIT WITH TWO INPUT NAND GATE: