Digital Logic & Design (20BDS0405)
DA 1

1). Convert the followings:-

(i) $(10111.0111)_2 = (?)_8$

↳ Sol:

Binary System	10	111	.	011	100
Octal Equivalent	2	7	.	3	4

$\therefore (10111.0111)_2 = (27.34)_8$

(ii) $(67.67)_8 = (?)_{10}$

↳ Sol: $(67.67)_8$

$= 6\times 8^1 + 7\times 8^0 + 6\times 8^{-1} + 7\times 8^{-2}$

$= 48 + 7 + \frac{6}{8} + \frac{7}{64}$

$= 55 + 0.75 + 0.109375$

$= 55.859375$

$\therefore (67.67)_8 = (55.859375)_{10}$.

(iii) $(10110.0101)_2 = (?)_4$.

↳ Sol:

Binary System	1	01	10	.	01	01
Quaternary Equivalent	1	1	2	.	1	1

$\therefore (10110.0101)_2 = (112.11)_4$

(iv). $(155)_{10} = (?)_2$

↳ Sol:

2	155	
2	77	→ 1
2	38	→ 1
2	19	→ 0
2	9	→ 1
2	4	→ 1
2	2	→ 0
2	1	→ 0
	0	→ 1

$\therefore (155)_{10} = (10011011)_2$

2) Perform :-

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(i) . 1100011 - 1011011 using 1's complement and 2's complement.

Using 1's complement.

Minuend → 1100011

Subtrahend → 1011011

1's complement of subtrahend = 0100100

$$
\begin{array}{r}
\therefore \quad 1100011 \\
+\ 0100100 \\
\hline
\boxed{1}0000111
\end{array}
$$

overflow bit (add to the rest).

$$
\begin{array}{r}
= \quad 0000111 \\
+\ \ \ \ 1 \\
\hline
0001000
\end{array}
$$

$\therefore (1100011)_2 - (1011011)_2 = (0001000)_2$

(ii). Using 2's complement,

Minuend → 1100011

Subtrahend → 1011011

2's complement of subtrahend = ~~[illegible]~~ 0100101

$$
\begin{array}{r}
\therefore \quad 1100011 \\
+\ 0100101 \\
\hline
\boxed{1}0001000
\end{array}
$$

overflow bit (Ignore).

$\therefore (1100011)_2 - (1011011)_2 = (1000)_2$

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(ii) 98 − 24 using 1's complement.

Sol: In binary representation, 98 = 01100010

24 = 00011000

In 1's complement form, −24 = 11100111

Then, 98 − 24 = 98 + (−24)

Hence,
```
  01100010
+ 11100111
----------
[1]01001001
```
overflow bit (add to the rest).

```
  01001001
+        1
----------
  01001010
```
→ Corresponding decimal form is :- 74

∴ $(98-24)_{10} = 74_{10}$.

(iii) 14 − 86 using 2's complement form :.

Sol: In binary representation, 14 = 00001110

86 = 01010110

In 2's complement form, −86 = 10101001 +1 = 10101010

Then, 14 − 86 = 14 + (−86) =
```
  00001110
+ 10101010
----------
  10111000
```
No-overflow bit, hence, find 2's complement of the resultant.

= 01000111 +1

= 01001000

In 2's complement of signed integer, it corresponds to : −72

8) Simplify using Boolean Expressions.

(i) $\bar{A}B(\bar{D}+\bar{C}D) + B(A+\bar{A}CD)$ to one literal.

Sol: $\bar{A}B(\bar{D}+\bar{C}D) + B(A+\bar{A}CD)$

$=\bar{A}B\bar{D}+\bar{A}B\bar{C}D+BA+B\bar{A}CD$ (Using Distributive Law).

$=\bar{A}B\bar{D}+\bar{A}BD(\bar{C}+C)+BA$ (using Distributive law).

$=\bar{A}B\bar{D}+\bar{A}BD+BA$ (using complement law).

$=\bar{A}B(\bar{D}+D)+BA$ (Using Distributive Law)

$=\bar{A}B+AB$ (Using Distributive law).

$=B(\bar{A}+A)$ (Using Complement law)

$=B$

(ii) $ABCD+A'B'C'D+A'BCD+AB'CD+A'B'CD+ABCD'$

Sol: $ABCD+A'B'C'D+A'BCD+AB'CD+A'B'CD+ABCD'$

$= BCD + A'B'D + AB'CD + ABCD'$ [∵ Distributive Law]

$= A'B'D + C(BD + AB'D + ABD')$ [Distributive Law].

$= A'B'D + C(D(B+A) + ABD')$ [" "]

$= A'B'D + C(DB+DA+ABD')$ [Distributive and complement law]

$= A'B'D + C(DB + A(D+BD'))$ [Distributive law]

$= A'B'D + C(DB + A(D+B))$ [Distributive and complement law]

$= A'B'D + C(DB+AD+AB)$ [Distributive law]

$= A'B'D + C(AB+D)$ [Reduction law].

$= A'B'D + ABC + DC$

(iii) $F = \prod(2,4,5,7,8,10)$, write the SOP.

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The corresponding TT is:-

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

From the truth table alongside, the canonical SOP form will be:-

$$F = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}BC\bar{D} + \bar{A}\bar{B}\bar{C}D + A\bar{B}CD + ABC\bar{D} + AB\bar{C}D + ABC\bar{D} + \bar{A}BCD$$

4). Simplify using K-Map:-

(i) $f = \Sigma(0,6,8,13,14) + d(2,4,10)$.

Sol: Here the corresponding 4-variable KMap will be:-

AB \ CD	00	01	11	10
00	1	X	0	0
01	X	0	0	1
11	0	1	0	1
10	1	0	0	X

Simplified boolean function corresponding to the KMap is:-

$$f = \bar{B}\bar{C}\bar{D} + AB\bar{C}D + BC\bar{D}$$

(iii) $F(v,w,x,y,z) = \Sigma m(4,5,8,9,12,13,18,20,21,22,25,28,30,31)$.

↳ Sol:

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Taking $v=0$,

wx \ yz	00	01	11	10
00				
01	1	1		
11	1	1		
10	1	1		

Taking $v=1$,

wx \ yz	00	01	11	10
00				1
01	1	1		1
11	1		1	1
10		1		

$$F = \bar{w}x\bar{y} + \bar{v}wy + x\bar{y}\bar{z} + v\bar{w}y\bar{z} + vwxy + vw\bar{x}\bar{y}z$$

(ii) $(A'+B+D')(A'+B'+C')(A'+B'+C)(B'+C+D')$.

↳ Sol:

The corresponding KMap will be :-

AB \ CD	00	01	11	10
00				
01		0		
11	0	0	0	0
10		0	0	

$(B'+C+D')$

$(A'+B'+C)$

$(A'+B'+C')$

$(A'+B+D')$

Considering No "don't care conditions", equivalent KMap will be :-

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

$\bar{A}\bar{B}$

$\bar{A}C$

$\bar{A}\bar{C}\bar{D}$

$\bar{B}\bar{D}$

$$\boxed{\therefore F = \bar{B}\bar{D} + \bar{A}\bar{B} + \bar{A}C + \bar{A}\bar{C}\bar{D}}$$

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A combinational circuit has four inputs (A, B, C and D) and four outputs (W, X, Y, Z). WXYZ represents an excess-3 coded number whose value equals the number of 1's at the input. For example, if ABCD = 1101, WXYZ = 0110.

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ⓐ. Find the minterm expansions of X, Y and Z.

ⓑ. Find the maxterm expansions of Y and Z.

Sol

A	B	C	D	No. of 1's	Excess-3	W	X	Y	Z
0	0	0	0	0	3	0	0	1	1
0	0	0	1	1	4	0	1	0	0
0	0	1	0	1	4	0	1	0	0
0	0	1	1	2	5	0	1	0	1
0	1	0	0	1	4	0	1	0	0
0	1	0	1	2	5	0	1	0	1
0	1	1	0	1	4	0	1	0	0
0	1	1	1	3	6	0	1	1	0
1	0	0	0	1	4	0	1	0	0
1	0	0	1	2	5	0	1	0	1
1	0	1	0	2	5	0	1	0	1
1	0	1	1	3	6	0	1	1	0
1	1	0	0	2	5	0	1	0	1
1	1	0	1	3	6	0	1	1	0
1	1	1	0	3	6	0	1	1	0
1	1	1	1	4	7	0	1	1	1

ⓐ Ans:- The minterm expansions are:-

$$X = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + \ldots$$
$$\ldots + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + A\bar{B}CD + AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + ABCD$$

$$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}BCD + A\bar{B}CD + AB\bar{C}D + ABC\bar{D} + ABCD$$

$$Z = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + ABCD$$

ⓑ Ans:- The maxterm expansions are:-

$$Y = (A+B+C+\bar{D})\cdot(A+B+\bar{C}+D)\cdot(A+B+\bar{C}+\bar{D})\cdot(A+\bar{B}+C+D)\cdot(A+\bar{B}+C+\bar{D})\cdot(A+\bar{B}+\bar{C}+D)\ldots$$
$$\ldots\cdot(\bar{A}+B+C+D)\cdot(\bar{A}+B+C+\bar{D})\cdot(\bar{A}+B+\bar{C}+D)\cdot(\bar{A}+\bar{B}+C+D).$$

$$Z = (A+B+C+\bar{D})\cdot(A+B+\bar{C}+D)\cdot(A+\bar{B}+C+D)\cdot(A+\bar{B}+\bar{C}+D)\cdot(A+\bar{B}+\bar{C}+\bar{D})\ldots$$
$$\ldots\cdot(\bar{A}+B+C+D)\cdot(\bar{A}+B+\bar{C}+\bar{D})\cdot(\bar{A}+\bar{B}+C+\bar{D})\cdot(\bar{A}+\bar{B}+\bar{C}+D).$$

6). Design a code Converter to convert Excess-1 to 8421 Code 20BDS0405

Sol: Let's consider a system of 4 inputs ABCD and 4 outputs WXYZ corresponding to excess-1 and 8421 codes respectively.

A	B	C	D	W	X	Y	Z
0	0	0	0	X	X	X	X
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	1
0	0	1	1	0	0	1	0
0	1	0	0	0	0	1	1
0	1	0	1	0	1	0	0
0	1	1	0	0	1	0	1
0	1	1	1	0	1	1	0
1	0	0	0	0	1	1	1
1	0	0	1	1	0	0	0
1	0	1	0	1	0	0	1
1	0	1	1	1	0	1	0
1	1	0	0	1	0	1	1
1	1	0	1	1	1	0	0
1	1	1	0	1	1	0	1
1	1	1	1	1	1	1	0

For W,

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

For X,

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

For Y,

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

For Z,

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

$W = AC + AD + AB\bar{C}$

$X = BC + BD + \bar{B}\bar{C}\bar{D}$

$Y = \bar{C}\bar{D} + \bar{A}CD + \bar{B}CD + AB\bar{D}$

$Z = \bar{C}\bar{D} + C\bar{D}$

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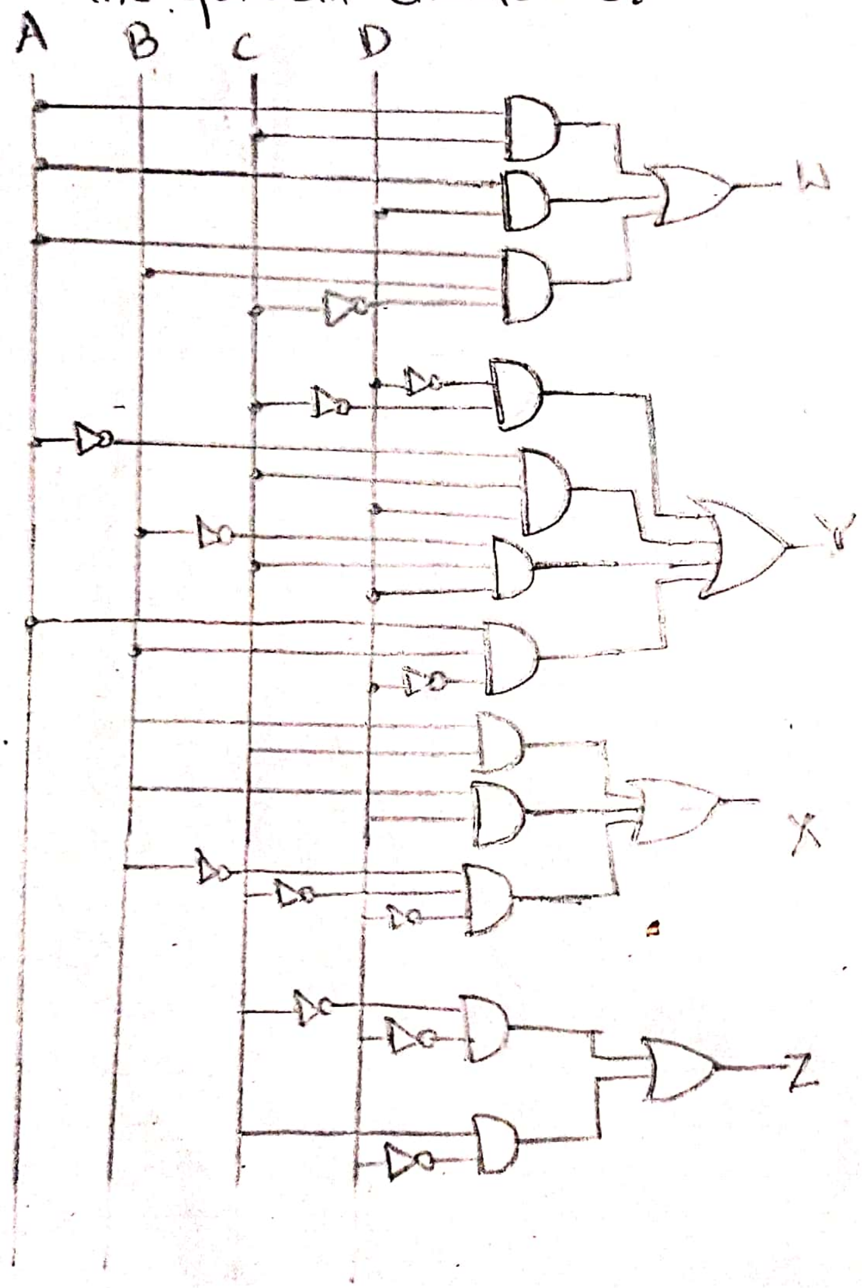
Here, $W = AC + AD + AB\overline{C}$

$X = BC + BD + \overline{B}\,\overline{C}\,\overline{D}$

$Y = \overline{C}\,\overline{D} + \overline{A}CD + \overline{B}CD + AB\overline{D}$

$Z = \overline{C}\,\overline{D} + C\overline{D}$

The equivalent circuits are :-



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