1) a) (i)

$$
\begin{array}{r}
657 \\
-589 \\
\hline
\end{array}
\qquad
\begin{array}{r}
0110 \quad 0101 \quad 0111 \\
-\ 0101 \quad 1000 \quad 1001 \\
\hline
0000 \quad 1100 \quad 1110 \\
-\quad\quad 0110 \quad 0110 \\
\hline
0110 \quad 1000
\end{array}
\qquad = (68)_{10}
$$

[1]

(ii) $(-14) + 6$

$\Rightarrow$ 2's of $-14 = 11110010$

$$
\begin{array}{r}
11110010 \\
+\ 00000110 \\
\hline
11111000 \longrightarrow 2's \\
= 10001000 \\
= (-8)_{10} \quad [1]
\end{array}
$$

b) Definition — [0.5]

Advantage over Ripple carry adder — [0.5]

c)

$A \oplus B$

[1]
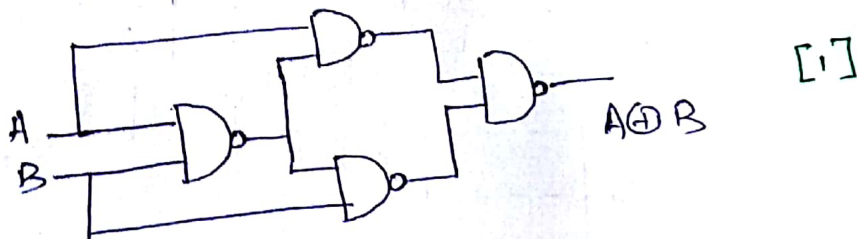
e d)

A_0	B_0	L	E	G
0	0	0	1	0
0	1	1	0	0
1	0	0	0	1
1	1	0	1	0

$L = \Sigma m(1)$
$E = \Sigma m(0,3)$
$G = \Sigma m(2)$

[0.5]

[0.5]
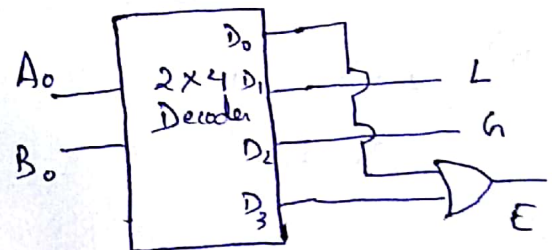
d) $C_3 C_2 C_1 = (010)_2 = (2)_{10}$

4 bit data $= 0001$
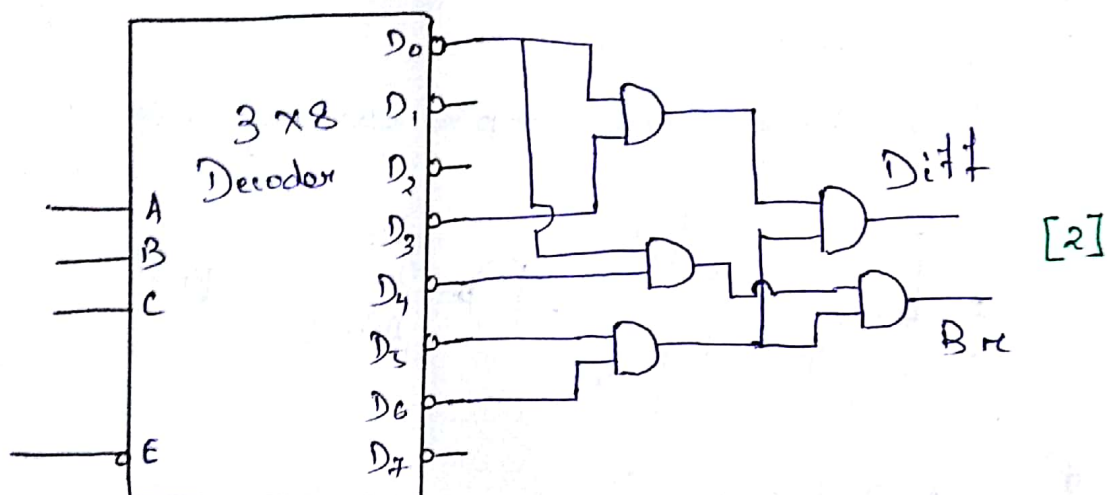
[1]

2) $f(A,B,C,D) = \Sigma m(1,5,6,12,13,14) + d(2,4)$

CD along top: 00 01 11 10
AB down side: 00, 01, 11, 10

$f = \bar{A}\bar{C}D + B\bar{D} + B\bar{C}$ [1]

Diagram — [2]

[2]

3) a) $Diff = \Sigma m(1,2,4,7) = \pi M(0,3,5,6)$ [1]
   $Br = \Sigma m(1,2,3,7) = \pi M(0,4,5,6)$

3×8 Decoder with inputs A, B, C, E and outputs $D_0, D_1, D_2, D_3, D_4, D_5, D_6, D_7$ — gates producing Diff and Br.

[2]

b) $\bar{A} + \bar{C} + (\bar{A} + \bar{B} + \bar{B} + \bar{C})$ [1]

$\Rightarrow \bar{A} + \bar{B} + \bar{C} = (\overline{A \cdot B \cdot C})$ [1]

4) a)

x	y	z	A	B	C
0	0	0	0	1	0
0	0	1	0	1	1
0	1	0	1	0	0
0	1	1	1	0	1
1	0	0	0	0	1
1	0	1	0	1	0
1	1	0	0	1	1
1	1	1	1	0	0

[1]

K-map for A:
$A = \bar{x}y + yz$

K-map for B:
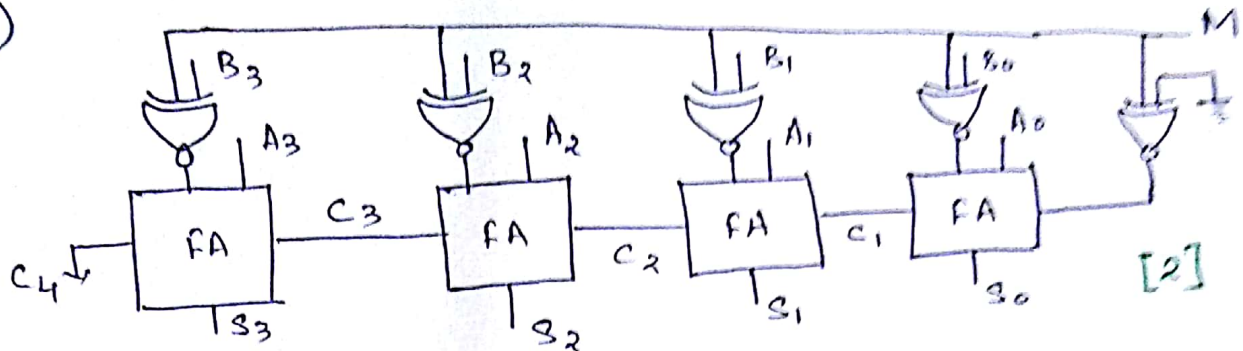$B = \bar{x}\bar{y} + \bar{y}z + xy\bar{z}$

$C = \bar{x}z + x\bar{z}$ Expressions of A, B & C — [1]

Diagram — [1]

b) Justification — [2]

5) a)

$M = 0 \rightarrow$ Subtraction
$\quad = 1 \rightarrow$ Addition.

Explanation — [1]

b) $AB + \bar{A}C + BCD = AB + \bar{A}C$.

LHS $AB + \bar{A}C + BCD$

$= AB + \bar{A}C + BCD \cdot 1$

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

$= AB + \bar{A}C + ABCD + \bar{A}BCD$

$= AB(1 + CD) + \bar{A}C(1 + BD)$

$= AB + \bar{A}C \quad (RHS)$ [2]