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Assignment : no 3

Subject : Digital Logic Design

Course code(CS): CSC-201

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Assignment No. 3

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Subject = DLD

Page = Bc (cs)

Q1

Using Boolean notation write an expression that is a 1 only when all of its variables (A, B, C and D) are 0s.

sol:

$$A + B + C + D = 0$$

when $A=0, B=0, C=0, D=0$ are

Q2 write an expression that is a 1 when one or more of its variables (A, B, C, D, and E) are 0s.

sol:

$$A + B + C + D = 1$$

if either $A=1$ or $B=1$ or $C=1$ or $D=1$

Q3:

write an expression that is a 0 when one or more of its variables (A, B and C) are 0s.

sol:

$$ABC$$

if either $A=0$ or $B=0$ or $C=0$

Ans Q4:

(a) $0+0+0+1 = 1$ Ans

(b) $1 \cdot 0 \cdot 1 \cdot 0 = 0$ Ans

(c) $1 \cdot 0 + 1 \cdot 0 + 0 \cdot 1 + 0 \cdot 1$

$0 + 0 + 0 + 0 = 0$ Ans

Ans Q5:

(a) $\overline{ABC} = 1$

only 1

$A=0, B=0 \Rightarrow \bar{A}=1, \bar{B}=1, C=1$

(b)

$\bar{A} + \bar{B} + C = 0$

only 1

$A=1, B=1 \Rightarrow \bar{A}=0, \bar{B}=0, C=0$
Ans

Ans Q6:

(a) $\overline{(ABC)(EFG)(HIJ)(KLM)}$

Sol

$\overline{(ABC)(EFG)(HIJ)(KLM)} \Rightarrow \bar{A} + \bar{B} = \bar{AB}$

$(ABC)(EFG)(HIJ)(KLM) \Rightarrow \bar{A} = A$
 $= (\bar{A}\bar{B} + \bar{C})(\bar{E} + \bar{F} + \bar{G})(\bar{H} + \bar{I} + \bar{J})(\bar{K} + \bar{L} + \bar{M}) \Rightarrow \bar{A}\bar{B}\bar{C} = \bar{A} + \bar{B} + \bar{C}$
Ans

(b)

$\overline{(A+B)(C+D)(E+f)(G+H)}$

$(A+B)(C+D)(E+f)(G+H) \Rightarrow \bar{A} = A$

$(\bar{A}\bar{B})(\bar{C}\bar{D})(\bar{E}\bar{F})(\bar{G}\bar{H}) \Rightarrow \bar{A} + \bar{B} = \bar{A}\bar{B}$
Ans

Ans Q7:

(a)

$$= (AB) + C$$

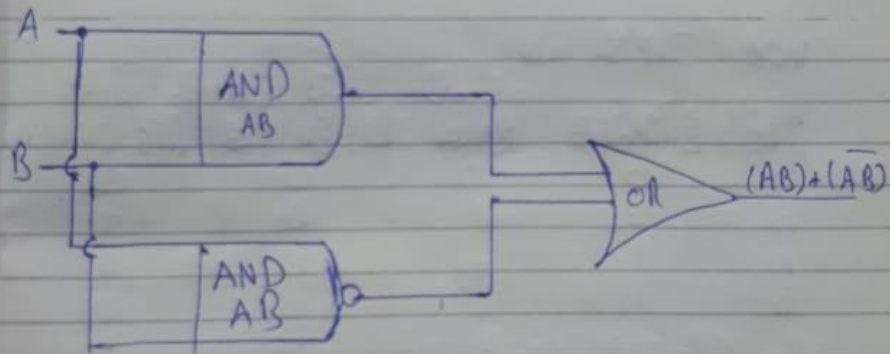
(b)

$$= (\overline{A}B) \text{ or } (A + \overline{B})$$

(c)

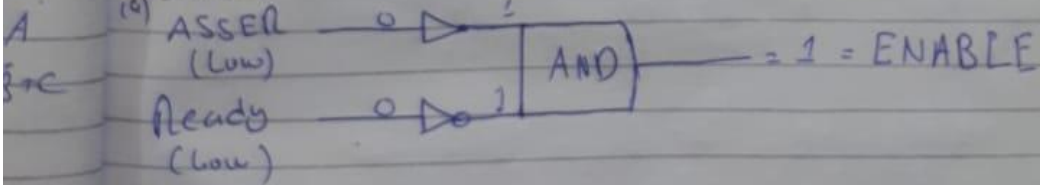
$$= (A+B)C$$

Ans Q8:

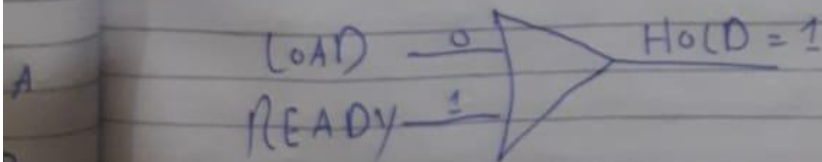


$\overline{B} = \overline{A}B$

Q9: (a)



(b)



Q10
Ans (a)

$$REGOY = (VCR + CAM) \cdot ROY$$

VCR	CAMI	ROY	VCR + CAMI	(VCR + CAMI) · ROY
0	0	0	0	0
0	0	1	0	0
0	1	0	1	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	1
1	1	0	1	0
1	1	1	1	1

(b)

~~VCR~~ ~~CAMI~~ ~~ROY~~

$$SEND = (RTS \cdot ENABLE) \cdot BUSY$$

RTS	ENABLE	BUSY	RTS · ENABLE	(RTS · ENABLE) · BUSY
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	1	0
1	1	1	1	1

Q11
M) Buz

$A \oplus B$

A	B	C	(A+B)	(B+C)	(C+A)	(A+B)(B+C)	(A+B)(B+C)(C+A)
0	0	0	0	0	0	0	0
0	0	1	0	1	1	0	0
0	1	0	1	1	0	1	0
0	1	1	1	1	1	1	1
1	0	0	0	0	1	0	0
1	0	1	0	1	1	1	1
1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1

(b)

sol

Buz

A	B	C	$\bar{A}\bar{B}\bar{C}$	$\bar{A}\bar{B}C$	$\bar{A}B\bar{C}$	$\bar{A}BC$	$A\bar{B}\bar{C}$	$A\bar{B}C$	$A\bar{B}C$	$A\bar{B}C$
0	0	0	1	1	0	0	0	0	0	0
0	0	1	0	1	0	1	0	1	1	1
0	1	0	0	0	1	0	0	1	1	1
0	1	1	0	0	0	1	0	1	1	1
1	0	0	1	1	0	0	1	0	1	1
1	0	1	1	1	0	1	1	1	1	1
1	1	0	1	0	1	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0

Q1A:

Ans
a) $A(A+B)$

Ans: $AA+AB \Rightarrow$ Distributive law

$$A+AB \Rightarrow AA=A \text{ Rule 7}$$

$$A \Rightarrow A+AB=A \text{ Rule 10}$$

(b) $A(A+\bar{A}B)$

$$A(A+B) \Rightarrow A+\bar{A}B = A+B \text{ Rule 11}$$

$$AA+AB \Rightarrow$$
 Distributive law

$$A+AB \Rightarrow$$
 Rule 7 $AA=A$

$$A \Rightarrow$$
 Rule 10 $A+AB=A$
Ans

(c) $BC+\bar{B}C$

$$CC \Rightarrow A+A=1 \text{ Rule 6}$$

$$C \Rightarrow AA=A \text{ Rule 7}$$
 Ans

(d) Same as b

(e) $A\bar{B}C + \bar{A}\bar{B}C + \bar{A}B\bar{C}$

$$\begin{aligned} A\bar{B}C + \bar{A}\bar{B}C + \bar{A}B\bar{C} &= \text{Rearranged} \\ (A+\bar{A})(\bar{B}C) + \bar{A}B\bar{C} &= \text{Refactor } \bar{B}C \text{ (distributive)} \\ 1(\bar{B}C) + \bar{A}B\bar{C} &= A+\bar{A}=1 \text{ Rule 6} \end{aligned}$$

$$\bar{B}C + \bar{A}B\bar{C} = A \cdot 1 = A \text{ Rule 4}$$

$$(\bar{A}+B)C = \text{Refactor } C \text{ (distributive)}$$

$$\bar{A}C + \bar{B}C = \text{Distributive law}$$

(F)

$$Bc + (\bar{B} + c)D + Bc$$

$$Bc + (\bar{B} + c)D = Bc + Bc = Bc$$

$$Bc + \bar{B}D + cD = \text{Distributive Law}$$

$$Bc + cD + \bar{B}D = \text{Rearranged}$$

$$Bc + \bar{B}D = c + cD = c \text{ Rule 10}$$

Ans

(g) $BcD [Bc + \bar{D} (cD + BD)]$

$$BcD [Bc + \bar{D} (cD + BD)]$$

$$BcD [Bc + cD\bar{D} + BD\bar{D}] \Rightarrow \text{Distributive Law}$$

$$BcD [Bc + c(0) + B(0)] \Rightarrow 0 \text{ Rule 9}$$

$$BcD (Bc) \Rightarrow A(0) = 0 \text{ Rule 3}$$

$$BcD Bc$$

$$BcD \Rightarrow (Bc)(Bc) = Bc$$

Ans

$$(b) \bar{A}\bar{B} + \bar{A}\bar{B}C + \bar{A}\bar{B}cD + \bar{A}\bar{B}cDE$$

$$\bar{A}\bar{B}(1+C) + \bar{A}\bar{B}cDE \quad \bar{A}\bar{B} \text{ Common}$$

$$\bar{A}\bar{B}(1) + \bar{A}\bar{B}cD + \bar{A}\bar{B}cDE \quad 1+C=1 \text{ Rule 2}$$

$$\bar{A}\bar{B}(1+cD) + \bar{A}\bar{B}cDE \quad \bar{A}\bar{B} \text{ Common}$$

$$\bar{A}\bar{B}(1) + \bar{A}\bar{B}cDE \quad 1+cD=1 \text{ Rule 2}$$

$$\bar{A}\bar{B}(1+cDE) \quad \bar{A}\bar{B} \text{ Common}$$

$$\bar{A}\bar{B}(1) \quad 1+cDE=1 \text{ Rule 2}$$

$$\bar{A}\bar{B} \text{ Ans}$$

Q13.

Ans

$$(a) = ((c\bar{D})+B)A + \bar{A}\bar{B}C = c\bar{D}A + BA + \bar{A}\bar{B}C$$

$$(b) = (\bar{A}\bar{B}) + (Ac\bar{D}) + (\bar{A}\bar{B}C) = (\bar{A}\bar{B}) + (Ac\bar{D})$$

$$(c) = (c\bar{D}\bar{B})\bar{B} + \bar{A}\bar{B}$$

$$d = (\bar{A}\bar{B}) + (Ac\bar{D})$$

b and d are equivalent.

Q14

Ans

$$(a) (C+D)(A+\bar{D})(A+\bar{B})(C+D)$$

$$CA + C\bar{D} + DA + D\bar{D}$$

$$C\bar{D} + CA + DA + 0 \Rightarrow D\bar{D} = 0 \text{ Rule 8}$$

$$C\bar{D} + AD(1+C) \Rightarrow \text{Factor AD}$$

$$C\bar{D} + AD(1) = 1+C = 1 \text{ Rule 2}$$

$$(C\bar{D}) + (AD) \text{ Ans}$$

$$(b) (A+C)(CD+Ac)$$

Ans

$$(A+C)(CD+Ac)$$

$$ACD + AAC + cCD = AC$$

$$ACD + AC + cD + AC \Rightarrow AA = A \text{ Rule 7}$$

$$ACD + AC + AC + cD$$

$$ACD + AC + cD \Rightarrow AC + AC + cD$$

$$AC(1+D) + cD \Rightarrow \text{Factor AC}$$

$$AC(D+cD) \Rightarrow 1+0 = 1 \text{ Rule 2}$$

$$(AC) + (cD)$$

Ans

$$(c) B + c [BD + (c + \bar{D})E]$$

$$B + c [BD + (CE + \bar{D}E)] \text{ distributive law}$$

$$B + c (BD + CE + \bar{D}E)$$

$$B + c (BE(D + \bar{D}) + CE) \Rightarrow \text{factor } BE$$

$$B + c (BE(1) + CE) \Rightarrow A + \bar{A} = 1 \text{ Rule 6}$$

$$B + c (BE + CE)$$

$$B + c (CE(1 + B)) \Rightarrow \text{factor } CE$$

$$B + c (BE(1)) \Rightarrow 1 + B = 1 \text{ Rule 9}$$

$$B + c (CE)$$

$$B + cCE \Rightarrow \text{distributive law}$$

$$B + cE \Rightarrow e + e = e \text{ Rule 7}$$

$$(d) A(A\bar{D} + C)$$

$$AA\bar{D} + AC \Rightarrow \text{distributive law}$$

$$A\bar{D} + AC \Rightarrow AA = A \text{ Rule 7}$$

$$(e) Bc +$$

$$Bc +$$

$$Bc +$$

$$Bc +$$

$$Bc +$$

$$Bc +$$

$$(f)$$

$$(E) Bc + DE (B\bar{c} + DE)$$

Distributive Law

$$Bc + DE (B\bar{c} + DE)$$

$$Bc + DEDE\bar{c} + DEDE \Rightarrow \text{Distributive Law}$$

$$Bc + DEDE\bar{c} + DEDE \Rightarrow DEDE = DE \text{ Rule 7}$$

$$Bc + DE (1 + B\bar{c}) = 1 + B\bar{c} = 1 \text{ Rule 2}$$

$$Bc + DE \quad A_1$$

$$(F) Bc(\bar{c}\bar{D}) + cE$$

$$Bc\bar{c}\bar{D} + Bc\bar{c}E \Rightarrow \text{Distributive Law}$$

$$B\bar{D}(c\bar{c}) + BE(cc) \Rightarrow \text{Reassociated}$$

$$B\bar{D}(0) + BE(cc) \Rightarrow c\bar{c} = 0 \text{ Rule 8}$$

$$cc = c \text{ Rule 7}$$

$$BcE$$

A_1 ,

Q15

Ans
(a) $C\bar{D} + AD$

$C\bar{D}$ is missing A.

$$= C\bar{D} = C\bar{D}(A + \bar{A}) \Rightarrow C\bar{D}A + C\bar{D}\bar{A}$$

AD is missing C

$$= AD = AD(C + \bar{C}) \Rightarrow ADC + AD\bar{C}$$

$$C\bar{D}A + C\bar{D}\bar{A} + ADC + AD\bar{C}$$

Ans.

(b) $(AC) + (CD)$

AC is missing D

$$= AC = AC(D + \bar{D}) \Rightarrow AC D + AC \bar{D}$$

CD is missing A

$$= CD = CD(A + \bar{A}) \Rightarrow CDA + C\bar{D}\bar{A}$$

$$ACD + AC\bar{D} + CDA + C\bar{D}\bar{A}$$

Ans

$$(c) B + CE$$

B is missing C and E

$$\Rightarrow B = B(C + \bar{C}) = BC + B\bar{C}$$

$$\Rightarrow BC = BC(E + \bar{E}) \Rightarrow BCE + BC\bar{E}$$

$$\Rightarrow B\bar{C}D = B\bar{C}(E + \bar{E}) \Rightarrow B\bar{C}E + B\bar{C}\bar{E}$$

CE is missing B

$$\Rightarrow CE = CE(B + \bar{B}) = CEB + CE\bar{B}$$

$$BCE + BC\bar{E} + B\bar{C}E + B\bar{C}\bar{E} + CEB + CE\bar{B}$$

Ans.

$$(d) A\bar{D} + AC$$

$A\bar{D}$ is missing C

$$\Rightarrow A\bar{D} = A\bar{D}(C + \bar{C}) \Rightarrow A\bar{D}C + A\bar{D}\bar{C}$$

AC is missing D

$$\Rightarrow AC = AC(D + \bar{D}) \Rightarrow AC\bar{D} + AC\bar{D}$$

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

Ans

$$(e) \quad Bc + BE$$

Bc is missing $(E \text{ and } D)$

$$\Rightarrow Bc = Bc(D + \bar{D}) \Rightarrow BcD + Bc\bar{D}$$

$$\Rightarrow BcD = BcD(E + \bar{E}) = BcDE + Bc\bar{E}D$$

$$\Rightarrow Bc\bar{D} = Bc\bar{D}(E + \bar{E}) = BcDE + Bc\bar{D}\bar{E}$$

DE is missing BC

$$\Rightarrow DE = DE(B + \bar{B}) = DEB + DE\bar{B}$$

$$\Rightarrow DEB = DEB(C + \bar{C}) = DEBC + DE\bar{B}\bar{C}$$

$$\Rightarrow DE\bar{B} = DE\bar{B}(C + \bar{C}) = DE\bar{B}C + DE\bar{B}\bar{C}$$

$$BcDE + BcD\bar{E} + Bc\bar{D}E + Bc\bar{D}\bar{E} + DEBC + DE\bar{B}\bar{C} + DE\bar{B}C + DE\bar{B}C$$

Ans

$$(f) \quad BcE$$

BcE is in standard SOP

Soln.

A

Q16

$$(a) C\bar{D}A + C\bar{D}\bar{A} + ADC + AD\bar{C}$$

$$\underline{\text{sol}} (C + \bar{D}A)(C + \bar{D}\bar{A})(A + D + C)(A + D + \bar{C})$$

$$(b) AcD + Ac\bar{D} + C\bar{D}\bar{A} + CDA$$

$$\underline{\text{sol}} (A + C + D)(A + C + \bar{D})(C + D + A)(C + D + A)$$

$$(c) BcE + Bc\bar{E} + B\bar{C}E + B\bar{C}\bar{E} + cEB + cE\bar{B}$$

$$\underline{\text{sol}} (B + C + E)(B + C + \bar{E})(B + \bar{C} + E)(B + \bar{C} + \bar{E}) \\ (C + E + B)(C + E + \bar{B})$$

$$(d) A\bar{D}C + A\bar{D}\bar{C} + AcD + Ac\bar{D}$$

$$\underline{\text{sol}} (A + \bar{D} + C)(A + \bar{D} + \bar{C})(A + C + D)(A + C + \bar{D})$$

$$(e) BcD\bar{E} + BcDE + Bc\bar{D}\bar{E} + BcD\bar{E} + D\bar{E}B\bar{C} \\ + D\bar{E}B\bar{C} + D\bar{E}\bar{D}C + D\bar{E}D\bar{C}$$

$$\underline{\text{sol}} (B + C + D + E)(B + C + D + \bar{E})(B + C + \bar{D} + E) \\ (B + C + \bar{D} + \bar{E})(D + E + B + C)(D + E + B + C) \\ (D + E + \bar{B} + C)(D + E + \bar{D} + \bar{C})$$

$$(f) BcE$$

$$(B + C + E)$$

Q17

Ans (a)

A	C	D	X	
0	0	0	0	
0	0	1	0	
0	1	0	1	$A\bar{C}\bar{D}$
0	1	1	0	
1	0	0	0	
1	0	1	1	$\bar{A}CD$
1	1	0	1	$A\bar{C}D$
1	1	1	1	ACD

(b)

A	C	D	X	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	$\bar{A}CD$
1	0	0	0	
1	0	1	0	
1	1	0	1	$AC\bar{D}$
1	1	1	1	ACD

(c)

B	C	E	X	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	$\bar{B}CE$
1	0	0	1	$B\bar{C}\bar{E}$
1	0	1	1	$B\bar{C}E$
1	1	0	1	$BC\bar{E}$
1	1	1	1	BCE

(d)

A
0
0
0
0
1
1
1
1

(e)

B
0
0
0
0
1
1
1
1

(f)

(d)

A	C	D	X	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	0	
1	0	0	1	$A\bar{C}\bar{D}$
1	0	1	0	
1	1	0	1	ACD
1	1	1	1	ACD

(e)

B	C	D	E	X	
0	0	0	0	0	
0	0	0	1	0	
0	0	1	0	0	
0	0	1	1	1	$B\bar{C}DE$
0	1	0	0	0	
0	1	0	1	0	
0	1	1	0	0	
0	1	1	1	1	$\bar{B}CDE$
1	0	0	0	0	
1	0	0	1	0	
1	0	1	0	0	
1	0	1	1	1	$B\bar{C}DE$
1	1	0	0	1	$BC\bar{D}E$
1	1	0	1	1	$BC\bar{D}E$
1	1	1	0	1	$BCDE$
1	1	1	1	1	$BCDE$

(f)

B	C	E	X	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	0	
1	0	0	0	
1	0	1	0	
1	1	0	0	
1	1	1	0	
1	1	1	1	BCE

Q18

Ans (a)

A	C	D	X	
0	0	0	0	$(A+C+D)$
0	0	1	0	$(A+C+\bar{D})$
0	1	0	0	$(\bar{A}+C+D)$
0	1	1	1	
1	0	0	1	
1	0	1	0	$(A+\bar{C}+D)$
1	1	0	1	
1	1	1	1	

(b)

A	C	D	X	
0	0	0	0	$(A+C+D)$
0	0	1	0	$(A+C+\bar{D})$
0	1	0	1	
0	1	1	1	
1	0	0	0	$(\bar{A}+C+D)$
1	0	1	1	
1	1	0	1	
1	1	1	1	

(c)

B	C	E	X	
0	0	0	0	$(B+C+E)$
0	0	1	0	$(B+C+\bar{E})$
0	1	0	0	$(B+\bar{C}+E)$
0	1	1	0	$(B+C+\bar{E})$
1	0	0	0	$(\bar{B}+C+E)$
1	0	1	1	
1	1	0	1	
1	1	1	1	

(d)

A	C	D	X	
0	0	0	0	$(A+C+D)$
0	0	1	0	$(A+C+\bar{D})$
0	1	0	1	
0	1	1	0	$(A+C+\bar{D})$
1	0	0	1	
1	0	1	1	
1	1	0	1	
1	1	1	1	

(c)

B	C	D	E	X	
0	0	0	0	0	$(B+C+D+E)$
0	0	0	1	0	$(B+C+D+\bar{E})$
0	0	1	0	0	$(B+C+\bar{D}+E)$
0	0	1	1	0	$(B+C+D+\bar{E})$
0	1	0	0	0	$(B+\bar{C}+D+E)$
0	1	0	1	1	
0	1	1	0	1	
0	1	1	1	1	
1	0	0	0	0	$(\bar{B}+C+D+E)$
1	0	0	1	1	
1	0	1	0	1	
1	0	1	1	1	
1	1	0	0	0	$(\bar{B}+\bar{C}+D+E)$
1	1	0	1	1	
1	1	1	0	1	
1	1	1	1	1	

(e)

B	C	E	X	
0	0	0	0	$(B+C+E)$
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

Q19.

Ans

A	B	C	D	X	
0	0	0	0	1	$(\bar{A}\bar{B}\bar{C}\bar{D})$
0	0	0	1	1	$(\bar{A}\bar{B}\bar{C}D)$
0	0	1	0	0	$(\bar{A}\bar{B}C\bar{D})$
0	0	1	1	1	$(\bar{A}\bar{B}CD)$
0	1	0	0	0	$(\bar{A}B\bar{C}\bar{D})$
0	1	0	1	1	$(\bar{A}B\bar{C}D)$
0	1	1	0	1	$(\bar{A}BC\bar{D})$
0	1	1	1	0	$(\bar{A}BCD)$
1	0	0	0	0	$(A\bar{B}\bar{C}\bar{D})$
1	0	0	1	1	$(A\bar{B}\bar{C}D)$
1	0	1	0	0	$(A\bar{B}C\bar{D})$
1	0	1	1	0	$(A\bar{B}CD)$
1	1	0	0	1	$(AB\bar{C}\bar{D})$
1	1	0	1	0	$(AB\bar{C}D)$
1	1	1	0	0	$(ABC\bar{D})$
1	1	1	1	0	$(ABCD)$

(b)

A C

A

=)

=

=

(c)

Q20.

Ans

$$\bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C}$$

$$000 \quad 001 \quad 101$$

$$(\bar{A}\bar{B})(\bar{A}\bar{B}C)$$

AB \ C	0	1
00	0	0
01		
11		
10		1

(b)

$$A \in (\bar{B} + C) \cdot A \in B + AC$$

AC is missing B.

$$\Rightarrow AC = AC(B+B) \Rightarrow ACB + AC\bar{B}$$

$$= AC\bar{B} + ACB + AC\bar{B} \Rightarrow AC\bar{B} + ACB = AC\bar{B}$$

$$= AC\bar{B} + ACB$$

AC	B	0	1
00			
01			
11		0	1
10			

$\Rightarrow (AC)A$

(c) $A(BC + B\bar{C}) + A(\bar{B}C + \bar{B}\bar{C})$

$$\bar{A}BC + \bar{A}B\bar{C} + ABC + AB\bar{C}$$

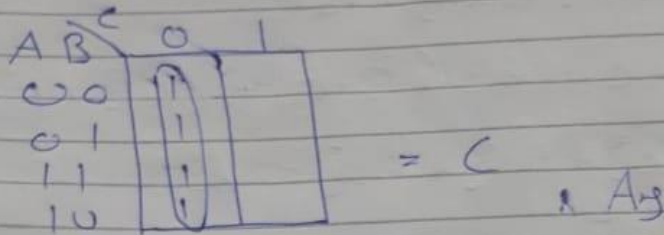
$$011 \quad 010 \quad 111 \quad 110$$

AB	C	0	1
00			
01		1	1
11		1	1
10			

$= B$

$$(d) \quad \overline{A}\overline{B}\overline{C} + A\overline{B}\overline{C} + \overline{A}B\overline{C} + A\overline{B}C$$

$$000 \quad 100 \quad 010 \quad 110$$



$$(e) \quad A + B\overline{C} + CD$$

A is missing BCD

$$A = A(B + \overline{B}) = AB + A\overline{B}$$

$$AB = AB(C + \overline{C}) = AB\overline{C} + ABC, \quad A\overline{B} = A\overline{B}(C + \overline{C}) = A\overline{B}C + A\overline{B}\overline{C}$$

$$A\overline{B}C = A\overline{B}C(D + \overline{D}) = A\overline{B}CD + A\overline{B}C\overline{D} \quad (1)$$

$$ABC = ABC(D + \overline{D}) = ABCD + ABC\overline{D} \quad (2)$$

$$A\overline{B}\overline{C} = A\overline{B}\overline{C}(D + \overline{D}) = A\overline{B}\overline{C}D + A\overline{B}\overline{C}\overline{D} \quad (3)$$

$$A\overline{B}C = A\overline{B}C(D + \overline{D}) = A\overline{B}CD + A\overline{B}C\overline{D} \quad (4)$$

$B\overline{C}$ is missing AD.

$$B\overline{C} = B\overline{C}(A + \overline{A}) = B\overline{C}A + B\overline{C}\overline{A}$$

$$B\overline{C}A = B\overline{C}A(D + \overline{D}) = B\overline{C}AD + B\overline{C}A\overline{D} \quad (5)$$

$$B\overline{C}\overline{A} = B\overline{C}\overline{A}(D + \overline{D}) = B\overline{C}\overline{A}D + B\overline{C}\overline{A}\overline{D} \quad (6)$$

CD is missing AB

$$AB = AB(C + \overline{C}) = ABC + AB\overline{C}$$

$$ABC = ABC(D + \overline{D}) = ABCD + ABC\overline{D} \quad (7)$$

$$AB\overline{C} = AB\overline{C}(D + \overline{D}) = AB\overline{C}D + AB\overline{C}\overline{D} \quad (8)$$

$$= \bar{A}\bar{B}cD + A\bar{B}cD + A\bar{B}c\bar{D} + A\bar{B}c\bar{D} + A\bar{B}c\bar{D} + A\bar{B}c\bar{D}$$

1011 1010 1111 1110 1001 1000

$$+ A\bar{B}cD + A\bar{B}c\bar{D} + B\bar{C}A\bar{D} + B\bar{C}A\bar{D} + B\bar{C}A\bar{D}$$

1101 1100 1011 1010 1001

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

1000

$$+ A\bar{B}c\bar{D} + A\bar{B}cD + A\bar{B}c\bar{D} + A\bar{B}c\bar{D}$$

1110 1111 1101 1101

		cD			
AB		00	01	11	10
00					
01		(1 1)			
11		(1 1 1 1)			
10					

(5) $\bar{A}\bar{B}c\bar{D} + A\bar{B}cD + A\bar{B}cD + A\bar{B}c\bar{D}$

		cD			
AB		00	01	11	10
00		(1 1)			
01					
11				(1 1)	
10					

$$= (\bar{A}\bar{B}) + (A\bar{B})$$

(a) $\bar{A}\bar{B} + A\bar{B} + \bar{C}\bar{D} + C\bar{D}$

$\bar{A}\bar{B}$ is missing CD

$\bar{A}\bar{B} = \bar{A}\bar{B}(C+\bar{C}) = \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}$

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

$\bar{A}\bar{B}\bar{C} = \bar{A}\bar{B}\bar{C}(D+\bar{D}) = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D}$

$A\bar{B}$ is missing CD

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

$\bar{C}\bar{D}$ is missing AB

$\bar{C}\bar{D} = A\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + \bar{A}\bar{B}C\bar{D}$

$C\bar{D}$ is missing AB

$C\bar{D} = A\bar{B}C\bar{D} + \bar{A}\bar{B}C\bar{D} + A\bar{B}C\bar{D} + \bar{A}\bar{B}C\bar{D}$

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

0011 0010 0011 0000 1011 1010

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

1001 1000 1100 0101 1000 0000

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

1110 0110 1010 0010

	$\bar{C}\bar{D}$			
AB	00	01	11	10
00	1	1	1	1
01		1		
11	1			
10	1	1	1	1

$= (\bar{A}\bar{B}) + (\bar{A}\bar{B}) + (A\bar{B}) + (A\bar{B})$

$$(b) \bar{A}B(\bar{C}\bar{D} + \bar{C}D) + AB(\bar{C}\bar{D} + \bar{C}D) \cdot A\bar{B}\bar{C}\bar{D}$$

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

0100 0101 1100 1101 1001

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

$= (B) + (A\bar{B}\bar{C}\bar{D})$

Q21

Ans

$$(\bar{A}\bar{B}\bar{C}) + (\bar{A}\bar{B}C) + (\bar{A}B\bar{C}) + (A\bar{B}\bar{C}) + (ABC)$$

0100 001 011 101 111

	C	
AB	0	1
00	1	1
01		1
11		1
10		1

$(\bar{A}\bar{B}) + (C)$

Q22

Ans

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

0001 0010 0100 0111 1000 1010

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

1100 1101 1111

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

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

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

Q23

Ans

$$(A+B\bar{C}) (\bar{A}+\bar{B}+\bar{C}) (A+\bar{B}+C) \quad (c)$$

AB \ C	0	1
00	0	0
01	0	0
11	0	0
10	0	1

$$= (A+C)(\bar{A}\bar{B}\bar{C})$$

Ans

(b) $(x+\bar{y})(\bar{x}+z)(x+\bar{y}+z)(\bar{x}+\bar{y}+z)$

$x+\bar{y}$ is missing z

$$x+\bar{y} = x+\bar{y} + (z\bar{z}) = (x+\bar{y}+z)(x+\bar{y}+\bar{z})$$

$\bar{x}+z$ is missing y

$$\bar{x}+z = \bar{x}+z + (y\bar{y}) = (\bar{x}+y+z)(\bar{x}+\bar{y}+z)$$

$$= (x+\bar{y}+z)(x+\bar{y}+\bar{z})(\bar{x}+y+z)(\bar{x}+\bar{y}+z)$$

$$\begin{matrix} 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{matrix}$$

$$+ (x+\bar{y}+z)(\bar{x}+\bar{y}+z)$$

$$\begin{matrix} 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \end{matrix}$$

xy \ z	0	1
00	0	0
01	0	0
11	0	0
10	0	0

$$= (x+\bar{y})(z)(\bar{x}+y)$$

Ans

Q25

* $(A+B+c \cdot D) (A+B+\bar{c} \cdot \bar{D}) (A+B+c+D) (A+B+c+\bar{D})$
 $(\bar{A}+B+c \cdot \bar{D}) + (\bar{A}+B+\bar{c}+\bar{D}) (\bar{A}+\bar{B}+\bar{c}+D)$

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

$(A+B+c+D) (A+\bar{B}+c) (A+B \cdot \bar{c} + \bar{D})$

$(\bar{A}+\bar{B}+\bar{c}+D) (A+B+\bar{D})$

Q26

(a) $(A+\bar{B}) (A+\bar{c}) (\bar{A}+\bar{B}+c)$

$A+\bar{B}$ is missing c

$A+\bar{B} = (A+\bar{B}+c) (A+\bar{B}+\bar{c})$

$A+\bar{c}$ is missing B.

$A+\bar{c} = (A+\bar{B}+\bar{c}) (A+B+\bar{c})$

$(A+\bar{B}+c) (A+\bar{B}+\bar{c}) (A+B+\bar{c}) (A+\bar{B}+\bar{c}) (\bar{A}+\bar{B}+c)$

		C	
AB		0	1
00		1	0
01		0	0
11		0	1
10		1	1

$= (\bar{A}\bar{B}\bar{c}) + (AC) + (A\bar{B})$

A₇

$B+c+\bar{D}$
1 0 1
)

(ch) $(\bar{A}+B)(\bar{A}+\bar{B}+\bar{C})(B+\bar{C}+D)(A+\bar{B}+c+\bar{D})$

$A+B$ is missing and D

$A+B = (\bar{A}+\bar{B}+c+\bar{D})(\bar{A}+B+c+\bar{D})(\bar{A}+B+c+\bar{D})$
 $(A+B+c+\bar{D})$

$\bar{A}+\bar{B}+\bar{C}$ is missing D

$\bar{A}+\bar{B}+\bar{C}$ is missing D

$\bar{A}+\bar{B}+\bar{C} = (\bar{A}+\bar{B}+\bar{C}+D)(\bar{A}+\bar{B}+\bar{C}+\bar{D})$

$B+\bar{C}+D$ is missing A

$B+\bar{C}+D = (A+B+\bar{C}+D)(\bar{A}+B+\bar{C}+D)$

$(\bar{A}+B+c+\bar{D})(\bar{A}+B+\bar{C}+D)(A+B+c+\bar{D})$
1 0 0 0 1 0 1 0 0 0 0 1

$(\bar{A}+B+\bar{C}+\bar{D})(\bar{A}+\bar{B}+\bar{C}+D)(A+\bar{B}+\bar{C}+\bar{D})$
1 0 1 1 1 1 1 0 1 1 1 1

$(A+B+\bar{C}+D)(\bar{A}+B+\bar{C}+D)(A+B+\bar{C}+\bar{D})$
0 0 1 0 1 0 1 0 0 1 1 1

	CD				
AB	00	01	11	10	
00	0	0	0	0	= $(\bar{A}\bar{C}\bar{D}) + (\bar{A}\bar{B}cD) + (Bc)$ $+ (\bar{A}Bc\bar{D}) + (A\bar{C}\bar{D})$
01	1	1	0	0	
11	1	1	0	0	
10	0	0	0	0	

A_7