Homework 1
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CMPT 33N

Problem

① NAND, NOR, $\equiv$

(a)

x	y	x nand y
0	0	1
0	1	1
1	0	1
1	1	0

NAND

(b)

x	y	x nor y
0	0	1
0	1	0
1	0	0
1	1	0

NOR

(c)

x	y	$x \equiv y$
0	0	1
0	1	0
1	0	0
1	1	1

$\equiv$

②

p	q	$p \to q$ Ⓐ	NOT P OR Q Ⓑ	Ⓐ $\equiv$ Ⓑ
0	0	1	1	1
0	1	1	1	1
1	0	0	0	1
1	1	1	1	1

$(p \to q) \equiv (\text{not } p \text{ or } q)$

(b)

p	q	
0	0	
0	1	
1	0	
1	1	

(b)

p	q	r	r OR NOT p (A)	q → (A) (B)	p → (B)
0	0	0	1	1	1
0	0	1	1	1	1
0	1	0	1	1	1
0	1	1	1	1	1
1	0	0	0	1	1
1	0	1	1	1	1
1	1	0	0	0	0
1	1	1	1	1	1

p → (q → (r OR NOT p))

(c)

p	q	p OR Q (A)	p AND Q (B)	(A) → (B)
0	0	0	0	1
0	1	1	0	0
1	0	1	0	0
1	1	1	1	1

(p OR Q) → (p AND Q)

③ exclusion

④

$\rightarrow$

$(P \rightarrow Q) \rightarrow R$

$P \rightarrow (Q \rightarrow R)$

NAND

(P NAND Q) NAND R

P NAND (Q NAND R)

NOR

(P NOR Q) NOR R

P NOR (Q NOR R)

⑤ ~~FALSE,~~ AND, XOR

* = commutative

⑥

*	*					*	*	*	*					*	*
FALSE	AND	A AND NOT B	A	NOT A AND B	B	XOR	OR	NOR	XNOR	NOT B	A OR NOT B	NOT A	NOT A OR B	NAND	TRUE
0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

(7) (a)

A	B	$\otimes$
0	0	0
0	1	1
1	0	1
1	1	0

b) Associtative ☒

$(A \otimes B) \otimes C \not\equiv$

$(A) \otimes (B \otimes C)$

Commutative ☑

$A \otimes B \equiv B \otimes A$

(8) (a) $= \bar{p}\bar{q}r + p\bar{q}\bar{r} + p\bar{q}r + pq\bar{r} + pqr$

(b) $= \bar{p}\bar{q}\bar{r} + \bar{p}\bar{q}r + \bar{p}q\bar{r}$

(9) (a) $(p+q+r)\cdot(p+\bar{q}+\bar{r})\cdot(p+\bar{q}+r)$

(b) $(p+\bar{q}+\bar{r})\cdot(\bar{p}+q+r)\cdot(\bar{p}+q+\bar{r})\cdot(\bar{p}+\bar{q}+r)\cdot(\bar{p}+\bar{q}+\bar{r})$

(c) $(x+y+c)\cdot(x+\bar{y}+\bar{c})\cdot(\bar{x}+y+\bar{c})\cdot(\bar{x}+\bar{y}+c)$

(10)

(a)

pq \ rs	00	01	11	10	pq
00	0	1	1	1	00
01	1	1	1	1	01
11	1	1	0	1	11
10	1	1	1	1	10

(11) (a) $\cancel{q\bar r + \bar p s + s p q + \bar r p q + \bar p s q + r \bar s q}$

(b) $\cancel{\bar p \bar r +}$

(11) (a) $p\bar r + r\bar p + \bar p q \bar r + p q r + \bar r \bar s \bar p + r \bar s p$

(b) $\bar q \bar s + \bar r \bar p + r \bar p \bar q + \cancel{s \bar r \bar p}\ \bar p r \bar s + \bar r p \bar s + p \bar r \bar q$

(c) $pqs + \overset{rpq}{\cancel{rpq}} + rq + rp + \bar r \bar s \bar q p + \bar r \bar s \bar p q + \bar r s \bar q \bar p + r \bar s \bar p \bar q$

(d) $\bar r + s + \bar p r + r \bar q$

(e) $\bar p + \bar r p \bar q$

(12)

	00		01		11		10	
	1	1	1	1	1	1	1	1
00	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1
01	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

A	B	AB
0	0	$\bar A \bar B$
0	1	$\bar A B$
1	0	$A \bar B$
1	1	AB

AB

B \ A	0	1
0	1	1
1	1	1

$A + \bar A + AB + \bar A B + \bar A \bar B +$
$B + \bar B + A\bar B$

$\therefore$ 64 combinations

(13) (a) $(\bar r + \bar p + q + \bar s)\cdot(p + q + r + s)$

(14)

(b) $\cancel{(q+s)\cdot(rp)}\cdot(\bar r + p + q)\cdot(p + \bar r + s)\cdot(r + \bar p + s)\cdot(\bar p r q)$

$\therefore \cancel{(q+r+s)\cdot(}$ $\therefore (r+p+q)\cdot(s+p+q)\cdot(q+r+s)\cdot(\bar p + r + s)$

(c) $(\bar p + \bar q + \bar r + \bar s)\cdot(\bar r + \bar p + q + s)\cdot(\bar r + \bar s + p + q)\cdot\cancel{(\bar r + \bar s + \bar p + q)}\ (\bar r + s + p + q)\cdot(r + s + \bar p + \bar q)\cdot(r + \bar s + \bar p + q)$
$\cdot(r + \bar s + p + \bar q)$

(d) $\cancel{\bar r \bar p q}$ $(p + q + r + \bar s)$

(e) $(p+q)\cdot(r+p)$

(b)

pq \ rs	00	01	11	10
00	Ø1	Ø1	1	Ø1
01	Ø1	Ø1	0	1
11	1	0	0	0
10	Ø1	1	0	1

$\bar{p}$ $\quad$ $\bar{s}\bar{q}$

(c)

pq \ rs	00	01	11	10
00	0	1	0	1
01	1	0	1	0
11	0	1	1	1
10	1	0	1	0

(d)

pq \ rs	00	01	11	10
00	1	1	Ø1	1
01	1	1	1	1
11	1	1	Ø1	0
10	1	1	1	1

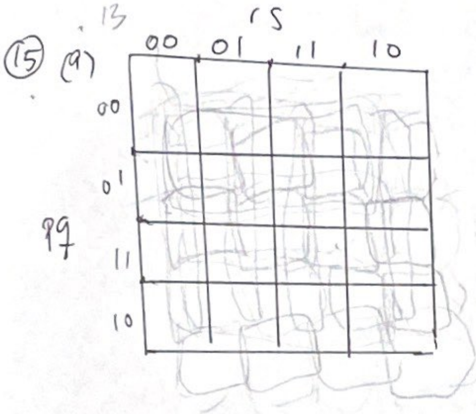
00
00
01
01
10
10 $\quad pqr\bar{s}$ $\quad r$
11
11

(e)

pq \ rs	00	01	11	10
00	Ø1	1	1	1
01	1	1	1	1
11	0	0	0	0
10	1	1	0	0

8421
0000

15 (a)



(a) 16 $(\bar{p}\bar{q}\bar{r})$, $(s\bar{p}\bar{q})$, $(r\bar{p}\bar{q})$, $(\bar{p}\bar{q}r\bar{s})$, $(\bar{p}q\bar{r})$, $(\bar{p}qs)$, $(\bar{p}qr)$, $(\bar{p}qr\bar{s})$, $(pq\bar{r})$, (pqs), (pqr) $(pqr\bar{s})$
$(p\bar{q}\bar{r})$, $(p\bar{q}s)$, $(p\bar{q}r)$
$(p\bar{q}r\bar{s})$

~~(b)~~ 16

(c) ~~4 $(\bar{p})$, $(\bar{q})$, $(\bar{r})$, $(\bar{s})$~~ 4 $(\bar{r}\bar{s})$, $(\bar{r}s)$, (rs), $(r\bar{s})$

(d) 4 $(\bar{p})$, $(\bar{q})$, $(\bar{r})$ $(\bar{s})$

(b) cont.

16 $(\bar{r}\bar{p})$, $(s\bar{p})$, $(r\bar{p})$, $(r\bar{s}\bar{p})$

$(q\bar{r})$, (qs), (qr), $(q\bar{s})$

$(p\bar{r})$, (ps), (pr), $(p, \bar{s})$

$(\bar{q}\bar{r})$, $(\bar{q}s)$, $(\bar{q}r)$, $(\bar{q}\bar{s})$

16

p	q	r	pqr (A)	p+q (B)	A→B
0	0	0	0	0	1
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	0	1	1
1	0	0	0	1	1
1	0	1	0	1	1
1	1	0	0	1	1
1	1	1	1	1	1

ANS: TAUTOLOGY

(b)

p	q	r	p → q (A)	q → r (B)	AB (C)	p → r (D)	C → D
0	0	0	1	1	1	1	1
0	0	1	1	1	1	1	1
0	1	0	1	0	0	1	1
0	1	1	1	1	1	1	1
1	0	0	0	1	0	0	1
1	0	1	0	1	0	1	1
1	1	0	1	0	0	0	1
1	1	1	1	1	1	1	1

ANS: Tautology

(c)

p	q	p → q (A)	A ⇒ p
0	0	1	0
0	1	1	0
1	0	0	1
1	1	1	1

ANS: NOT TAUTOLOGY

d)

p	q	r	q+r (A)	p≡A (B)	pr (C)	q→C (D)	B → D
0	0	0	0	1	0	1	1
0	0	1	1	0	0	1	1
0	1	0	1	0	0	0	1
0	1	1	1	0	0	0	1
1	0	0	0	0	0	1	1
1	0	1	1	1	1	1	1
1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1

ANS: Tautology

17 (a) $f(x) \rightarrow$ True

$f(y) \Rightarrow$ True

$f(x) \Leftrightarrow f(y)$

(b) $f(\text{true}) \rightarrow$ True

$f(\text{false}) \rightarrow$ True

18

$p \equiv p$

1

p	p	$p \equiv p$
0	0	1
0	0	1
1	1	1
1	1	1

2

p	q	$p \equiv q$ (A)	$q \equiv p$ (B)	$A \equiv B$
0	0	1	1	1
0	1	0	0	1
1	0	0	0	1
1	1	1	1	1

3

cmon...

(19) $x+y \equiv p$

$yz \equiv q$

$(x) = r$

(1) $(x+y) \equiv (x+y)$

(2) $((x+y) \equiv (yz)) \equiv (yz \equiv (x+y))$

(3)

Cmon...

(22)

1. $(\bar{p}+\bar{q})(pr) \therefore (\bar{p}+\bar{q})(pr)$

2. $(\bar{r}s)$

~~not~~ $\bar{p}+q\bar{r}s$

$= p\bar{q}r\bar{s}$

(23) 1. $y+w\overline{xz}$

2. $\cancel{(wz(}(y+\bar{z})(\bar{w}+\bar{x}+\bar{y})$