Homework 1
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CMPT 33N

81/100

Problem

① NAND, NOR, ≡

(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 ≡ y
0	0	1
0	1	0
1	0	0
1	1	1

≡ ✓

②

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

✓

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

(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

✓

$p \rightarrow (q \rightarrow (r \text{ OR NOT } p))$

(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

✓

$(p \text{ OR } q) \rightarrow (p \text{ AND } q)$

③ exclusion ✓

④

→

$(P \to Q) \to R$ $\quad P: \emptyset, q: 1, r: \emptyset$ ✓

$P \to (Q \to R)$

NAND

$(P \cdot \text{NAND } Q) \text{ NAND } R$ $\quad p: \emptyset, q: \emptyset, r: 1$ ✓

$P \text{ NAND } (Q \text{ NAND } R)$

NOR

$(P \text{ NOR } Q) \text{ NOR } R$ $\quad p: \emptyset, q: \emptyset, r: 1$ ✓

$P \text{ NOR } (Q \text{ NOR } R)$

⑤ ~~FALSE~~, AND, XOR

TRUE

$p, q, \text{not } p, \text{not } q$

-3

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

not(A→B) not(B→A) A≡B A→B

* = commutative

⑦ a)

A	B	⊗
0	0	0
0	1	1
1	0	1
1	1	0

✓

b) Associative ☒

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

Commutative ☑ ✓

$A \otimes B = B \otimes A$

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

(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
00	0	1	1	1
01	1	1	1	1
11	1	1	0	1
10	1	1	1	1

✓

what about the rest? (-3)

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

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

-2

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

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

(c) $pqs + r\bar{p}\bar{q}$ (corrected to $rp\bar{q}$) $+ r\bar{q} + rp + \bar{r}\bar{s}\bar{q}p + \bar{r}\bar{s}\bar{p}q + \bar{r}s\bar{q}\bar{p} + r\bar{s}\bar{p}\bar{q}$ ✓

(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

✓

$A + \bar{A} + AB + \bar{A}B + \bar{A}\bar{B} +$
$B + \bar{B} + A\bar{B}$
∴ 64 combinations

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

(14)

(b) ~~$(\bar{q}+s)\cdot(rp)$~~$\cdot(\bar{r}+p+\bar{q})\cdot(p+\bar{r}+s)\cdot(r+\bar{p}+s)\cdot(\bar{p}r\bar{q})$ ✗ -2

~~∴ $(\bar{q}+r+s)\cdot($~~ ∴ $(r+p+\bar{q})\cdot(s+p+\bar{q})\cdot(\bar{q}+r+s)\cdot(\bar{p}+r+s)$

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

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

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

(b)

q_d \ sr	00	01	11	10
0	1	1	1	1
1	1	1	0	1
1	1	0	0	0
0	1	1	0	1

(c)

q_d \ sr	00	01	11	10
0	0	1	0	1
1	1	0	1	0
0	1	1	1	1
1	1	0	1	0

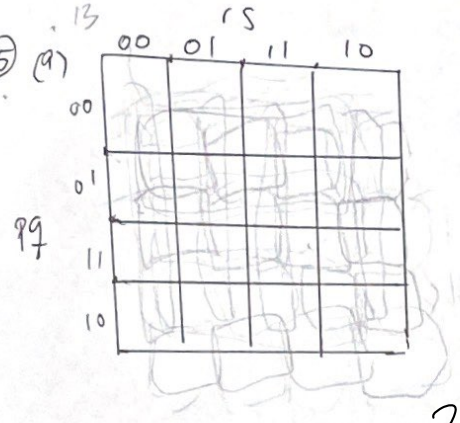
(d)

q_d \ sr	00	01	11	10
0	1	1	1	1
1	1	1	1	1
1	1	1	1	0
0	1	1	1	1

(e)

q_d \ sr	00	01	11	10
0	1	1	1	1
1	1	1	1	1
1	0	0	0	0
0	1	1	0	0

(15) (a)



-1

32

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

(b) ~~16~~ 9

(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.

9 $(\bar{r}\bar{p})$, $(s\bar{p})$, $(\bar{r}\bar{p})$, $(\bar{r}\bar{s}\bar{p})$

$(q\bar{r})$, $(q\bar{s})$, (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)	(A) ∧ (B) (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→p (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

(B) (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

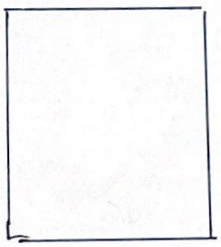
(8) $P \equiv P$

①

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

②

q	q	$p \Rightarrow q$	$q \equiv p$	$p \Leftrightarrow q$
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...

20) ? - 4

21) ? - 4

(22)

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

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

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

$= p\bar{q}rs$

(23) 1. $y + w\bar{x}z$ ✓

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