

# Assignment - I DS

Q1.

$$\begin{aligned} \text{a. } \neg(P \rightarrow Q) &\equiv P \wedge \neg Q \\ \neg(\neg P \vee Q) &\equiv P \wedge \neg Q \\ \neg(\neg P) \wedge \neg Q &\equiv P \wedge \neg Q \\ P \wedge \neg Q &\equiv P \wedge \neg Q \end{aligned}$$

$$\begin{aligned} \text{b. } (P \wedge Q) \rightarrow (P \vee Q) &\equiv T \\ \neg(P \wedge Q) \vee (P \vee Q) &\equiv T \\ (\neg P \vee \neg Q) \vee (P \vee Q) &\equiv T \\ (\neg P \vee P) \vee (\neg Q \vee Q) &\equiv T \\ T \vee T &\equiv T \\ T &\equiv T \end{aligned}$$

$$\text{c. } \neg(A \wedge (\neg B)) \leftrightarrow (A \rightarrow B)$$

A	B	$\neg B$	$(A \wedge \neg B)$	$\neg(A \wedge \neg B)$	$(A \rightarrow B)$	$\neg(A \wedge (\neg B)) \leftrightarrow (A \rightarrow B)$
T	T	F	F	T	T	T
T	F	T	T	F	F	T
F	T	F	F	T	T	T
F	F	T	F	T	T	T

so a tautology.

Q2

$$\text{a. } \neg(p \leftrightarrow q) \equiv p \leftrightarrow \neg q$$

$\neg(p \leftrightarrow q)$ truth table.	p	q	$(p \leftrightarrow q)$	$\neg(p \leftrightarrow q)$
	T	T	T	F
	T	F	F	T
	F	T	F	T
	F	F	T	F



$p \leftrightarrow \neg q$   
truth table

p	q	$\neg q$	$p \leftrightarrow \neg q$
T	T	F	F
T	F	T	T
F	T	F	T
F	F	T	F

$\neg(p \leftrightarrow q) \equiv p \leftrightarrow \neg q$   
are logically equivalent.

b.  $(p \wedge q) \rightarrow (p \rightarrow q)$   
 $(p \wedge q) \rightarrow (\neg p \vee q)$   
 $\neg(p \wedge q) \vee (\neg p \vee q)$   
 $\neg p \vee \neg q \vee \neg p \vee q$   
 $(\neg p \vee \neg p) \vee (\neg q \vee q)$   
 $\neg p \vee T$   
 $T$

c.  $\neg(A \wedge (\neg B)) \leftrightarrow (A \rightarrow B)$

A	B	$\neg B$	$(A \wedge \neg B)$	$\neg(A \wedge \neg B)$	$(A \rightarrow B)$	$\neg(A \wedge \neg B) \leftrightarrow (A \rightarrow B)$
T	T	F	F	T	T	T
T	F	T	T	F	F	T
F	T	F	F	T	T	T
F	F	T	F	T	T	T

a tautology man.

Q3

a.  $p \vee (\neg p)$

$p \vee (\neg p) \equiv T$  Negation Law

p	$\neg p$	$p \vee \neg p$
T	F	T
F	T	T

$p \vee \neg p$  is a tautology.



b.  $(p \vee q) \vee [(\sim p) \wedge (\sim q)]$

p	q	$\sim p$	$\sim q$	$p \vee q$	$\sim p \wedge \sim q$	$(p \vee q) \vee [(\sim p) \wedge (\sim q)]$
T	T	F	F	T	F	T
T	F	F	T	T	F	T
F	T	T	F	T	F	T
F	F	T	T	F	T	T

$(p \vee q) \vee [(\sim p) \wedge (\sim q)]$  is a tautology.

Q4

1.

a.  $(p \vee q) \rightarrow (p \wedge q)$

p	q	$(p \vee q)$	$(p \wedge q)$	$(p \vee q) \rightarrow (p \wedge q)$
T	T	T	T	T
T	F	T	F	F
F	T	T	F	F
F	F	F	F	T

b.  $\sim(p \wedge q) \wedge (\sim r)$

p	q	r	$\sim r$	$p \wedge q$	$\sim(p \wedge q)$	$\sim(p \wedge q) \wedge \sim r$
T	T	T	F	T	F	F
T	F	F	T	F	T	T
F	T	F	T	F	T	T
F	F	T	F	F	T	F
T	F	T	F	F	T	F
T	T	F	T	T	F	F
F	T	T	F	F	T	F
F	F	F	T	F	T	T



2.

a.  $p \vee T \equiv T$  (Domination Law)

b.  $F \wedge p \equiv F$  (Domination Law)

c.  $\bar{T} \vee F \equiv F$

$\sim T \vee F$

$F \vee F$

d.  $2+2=4$  if and only if  $1+1=2 \equiv T$   $T \leftrightarrow T \equiv T$

e.  $1+1=3$  if and only if monkeys can fly.  $\equiv T$   $F \leftrightarrow F \equiv T$

Q5.

a. One Plus smartphone does not have 32 GB of memory.

b. There is at least one student in your class who has not taken a course in calculus.

c. There is no student in this class who has taken a course in calculus.

d. The summer in Maine is not hot or it is not ~~sunny~~ humid.

e. There are not 13 items in a baker's dozen.

Q6. 1.

a.  $11000 \wedge (01011 \vee 11011)$

$11000 \wedge 11011$

$11000$

$01011$

$11011$

OR  $11011$

$11000$

$11011$

AND  $11000$

b.  $(01111 \wedge 10101) \vee 01000$

$00101 \vee 01000$

$00000$

$01101$

$01111$

$10101$

AND  $00101$

$00101$

$01000$

OR  $01101$



$$(01010 \oplus 11011) \oplus 01000$$

$$10001 \oplus 01000$$

$$11001$$

$$\begin{array}{r} 01010 \\ 11011 \\ \hline \text{XOR } 10001 \end{array}$$

$$d. (11011 \vee 01010) \wedge (10001 \vee 11011)$$

$$11011 \wedge 11011$$

$$11011$$

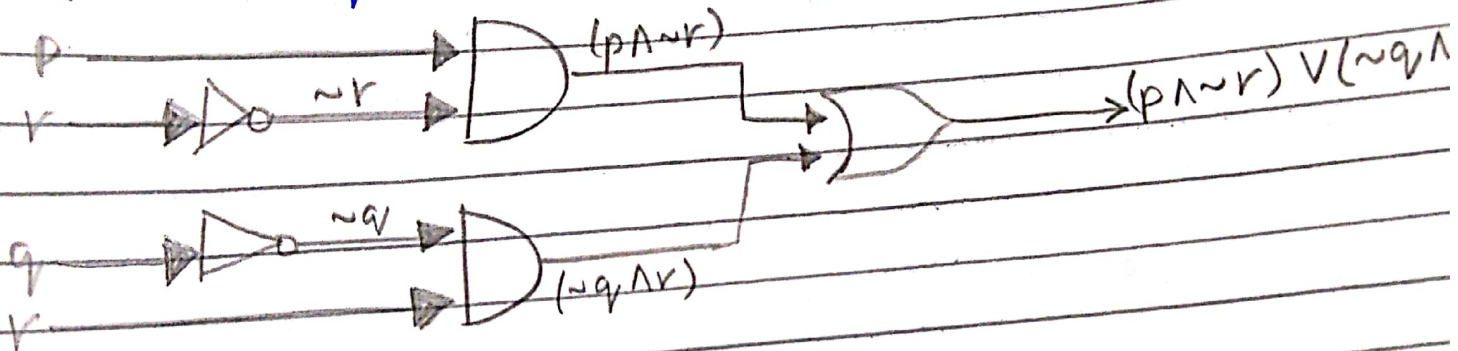
$$\begin{array}{r} 11011 \\ 01010 \\ \hline \text{OR } 11011 \end{array}$$

$$\begin{array}{r} 10001 \\ 11011 \\ \hline \text{OR } 11011 \end{array}$$

$$\begin{array}{r} 11011 \\ 11011 \\ \hline \text{AND } 11011 \end{array}$$

2.

$$(p \wedge \sim r) \vee (\sim q \wedge r)$$



3. You can ride the roller coaster —  $c$   
 You cannot ride the roller coaster —  $\sim c$   
 You are under 4 feet tall —  $f$   
 You are older than 16 years old —  $o$

$$(f \wedge \sim o) \rightarrow (\sim c)$$