

CS2022/MA2201
HW#1 SOLUTIONS

1. (a) $((h \wedge w) \wedge \neg s)$
 (b) $(\neg w \wedge (h \wedge s))$
 (c) $((\neg h \wedge \neg w) \wedge \neg s)$

2. (a)

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

(b)

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

3. (a) and (b)

p	$p \oplus p$	$p \oplus \neg p$
F	F	T
T	F	T

(c), (d), (e) and (f)

p	q	$p \oplus \neg q$	$\neg p \oplus \neg q$	$(p \oplus q) \vee (p \oplus \neg q)$	$(p \oplus q) \wedge (p \oplus \neg q)$
F	F	T	F	T	F
F	T	F	T	T	F
T	F	F	T	T	F
T	T	T	F	T	F

4. (a) $(q \wedge (p \rightarrow q)) \rightarrow p$ is not a tautology. It is F in case p is F and q is T .

(b) $(p \vee \neg p)$ is a tautology.

(c) $(p \rightarrow q) \rightarrow (q \rightarrow p)$ is not a tautology. It is F in case p is F and q is T .

$$\begin{aligned}
5. \quad p \wedge (\neg p \vee q) &\Leftrightarrow (p \wedge \neg p) \vee (p \wedge q) && \text{(Distributive Law)} \\
&\Leftrightarrow F \vee (p \wedge q) && \text{(since } p \wedge \neg p \Leftrightarrow F) \\
&\Leftrightarrow (p \wedge q) \vee F && \text{(Commutative Law)} \\
&\Leftrightarrow (p \wedge q) && \text{(Identity Law)} \\
&\Leftrightarrow (q \wedge p) && \text{(Commutative Law)}
\end{aligned}$$

$$6. (a) (\exists x)(\exists y)Q(x, y)$$

$$(b) \neg(\exists x)(\exists y)Q(x, y) \text{ or } (\forall x)(\forall y)\neg Q(x, y)$$

$$(c) (\exists x)(Q(x, \textit{Jeopardy}) \wedge Q(x, \textit{Wheel_of_Fortune}))$$

$$(d) (\forall y)(\exists x)Q(x, y)$$

$$(e) (\exists x)(\exists y)(Q(x, \textit{Jeopardy}) \wedge Q(y, \textit{Jeopardy}) \wedge x \neq y)$$