

COMP 1805 Assignment 1

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1. A.) It is cold outside or I am Canadian
B.) It is not January and it is not cold
C.) If I am Canadian and it is January then it is not cold outside
D.) It is cold outside or I am Canadian but not both

2. A.) Let P be the proposition I like computer science
Let Q be the prop. I like teaching
Let r be the prop. I like to email
Solution: $p \wedge q \wedge \neg r$
B.) Let A be the prop. That it is early
Let B be the prop. That I need to drink coffee
Solution: $A \rightarrow B$
C.) Let C be the prop. I was born in Canada
Solution: $C \oplus \neg C$
D.) Let A be the prop. You are my instructor
Let B be the prop. I am a Carleton student
Solution: $A \leftrightarrow B$

3. A.) False
B.) True
C.) False
D.) True

4. $(p \vee q) \leftrightarrow (q \vee \neg r)$
 $= \neg(q \wedge p) \leftrightarrow (q \wedge \neg r)$ DeMorgans Law
 $= \neg(q \wedge p) \leftrightarrow \neg(\neg r \wedge q)$ DeMorgans law
 $= \neg q \wedge \neg p \leftrightarrow r \wedge \neg q$ Double Negeation and Distributive Law
 $= (\neg q \wedge \neg p) \rightarrow (r \wedge \neg q) \wedge (r \wedge \neg q \rightarrow \neg q \wedge \neg p)$ Biconditional Law

5. $(\neg q \wedge \neg p) \rightarrow (r \wedge \neg q) \wedge (r \wedge \neg q \rightarrow \neg q \wedge \neg p)$
 $= \neg q \wedge \neg p \leftrightarrow r \wedge \neg q$ Biconditional Law (reversed)
 $= \neg(q \wedge p) \leftrightarrow \neg(\neg r \wedge q)$ Double negation and distributive laws
 $= \neg(q \wedge p) \leftrightarrow (q \wedge \neg r)$ DeMorgans law
 $= (p \vee q) \leftrightarrow (q \vee \neg r)$

7. A.) $\neg(\neg(p \wedge \neg(\neg q \wedge q))) \wedge \neg\neg p$

P	Q	$\neg Q$	$Q \wedge \neg Q =$ (r)	$P \wedge r = (s)$	$s \wedge P$
T	T	F	F	F	F
T	F	T	F	F	F
F	T	F	F	F	F
F	F	T	F	F	F

Contradiction

B.) $(q \leftrightarrow ((p \vee r) \wedge r)) \wedge \neg(p \rightarrow p)$

To preserve time I excluded some columns

Q	P	R	$(q \leftrightarrow ((p \vee r) \wedge r))$ $\wedge \neg(p \rightarrow p)$
T	T	T	F
T	T	F	F
T	F	T	F
T	F	F	F
F	T	T	F
F	T	F	F
F	F	T	F
F	F	F	F

Contradiction

C.) $((p \wedge r) \vee q \vee (p \wedge \neg r)) \wedge (r \vee p)$

P	Q	R	$((p \wedge r) \vee q \vee (p \wedge \neg r)) \wedge (r \vee p)$
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	T
F	T	T	T
F	T	F	F
F	F	T	F
F	F	F	F

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Contingency

$$\begin{aligned}
 8. \quad \text{A.) } & \neg(\neg(p \wedge \neg(\neg q \wedge q)) \wedge \neg\neg p) \\
 & = \neg(\neg(p \wedge (q \wedge \neg q)) \wedge p) && \text{distributive law and double negation law} \\
 & = p \wedge (q \wedge \neg q) \wedge p && \text{distributive law and double negation law} \\
 & = p \wedge p \wedge (q \wedge \neg q) \\
 & = p \wedge F && \text{Idempotent and Negation} \\
 & = T
 \end{aligned}$$

The logical equivalence is a tautology

$$\begin{aligned}
 \text{b.) } & (q \leftrightarrow ((p \vee r) \wedge r)) \wedge \neg(p \rightarrow p) \\
 & = F \\
 & \text{The equivalence is a contradiction}
 \end{aligned}$$

$$\begin{aligned}
 \text{c.) } & (((p \wedge r) \vee q \vee (p \wedge \neg r)) \wedge (r \vee p)) \\
 & = p \vee (r \vee q) \vee (p \vee \neg r) \wedge (r \vee p) && \text{Associative} \\
 & = \text{Contingency}
 \end{aligned}$$

9. A.) P(x) = x is a penguin
 Q(x) = x is a bird
 R(x) = x eats squid
 There exists in the animal kingdom, it is true that if x is a penguin then x eats squid

b.) There exists an animal on earth this a both a penguin and a bird

c.) For all animals on earth, it is true that if x is a bird then x is a penguin or x does not eat squid

10.

Let P be the prop. X is a penguin

Let Q be the prop that x is aquatic

Let R be the prop that x can fly

Let S be the prop that x eats squid

a.) $\forall x(P(x) \rightarrow (Q(x) \wedge R(x)))$

b.) $\exists x P(x) (\neg S(x) \wedge R(x))$

