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CS-225: Discrete Structures in CS

Homework 1, Part 1
Exercise Set #2.1
Problems: Problem #5(b, c, d), #8(c), #10(e), #30, #37, #39, #43, #45, #49, #54

5
b) Not a statement: Pronoun "she" is ambiguous
c) Statement: Because it is false.
d) Not a statement: Depends on the variable x

8
c) $\neg h \wedge \neg w \wedge \neg s$

10
e) $\neg p \vee (q \wedge r)$

30
The sentence has the structure: $p \wedge q$. Using De Morgan's law the negation is $\neg p \vee \neg q$.

Therefore, the negation is: The dollar is not at an all-time high or the stock market is not at a record low.

37
The statement is equal to: $(0 > x) \wedge (x \geq -7)$. Therefore, using De Morgan's laws the negation is: $(0 \leq x) \vee (x < -7)$.

39
The statement has the form: $(p \wedge q) \vee (\neg p \wedge r \wedge s)$
Negation: $(\neg p \vee \neg q) \wedge (p \vee \neg r \vee \neg s)$ (from De Morgan's Law)
Therefore the negation of the statement is:

(num_orders ≥ 50 or num_instock ≤ 300) and (50 > num_orders or num_orders ≥ 75 or num_instock ≤ 500)

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

Therefore, $(\neg p \vee q) \vee (p \wedge \neg q)$ is a tautology.

45
Let p = "Bob is both a Computer Science and Math major"

Let r = "Ann is a Math major"
let s = "Ann is a Computer Science major"

Sentence 1: $p \wedge r \wedge \neg(r \wedge s)$

Sentence 2: $\neg(p \land (r \land s)) \land (r \land p)$

Simplifying Sentence 1:

$p \land r \land \neg(r \land s)$	
$p \land r \land (\neg r \lor \neg s)$	De Morgan's Law
$p \land ((r \land \neg r) \lor (r \land \neg s))$	Distributive Law
$p \land ((c) \lor (r \land \neg s))$	Negation Law (c = contradiction)
$p \land ((r \land \neg s) \lor (c))$	Commutative Law
$p \land (r \land \neg s)$	Identity Law
$p \land r \land \neg s$	Associative Law

Simplifying Sentence 1:

$\neg(p \land (r \land s)) \land (r \land p)$	
$(\neg p \lor \neg(r \land s)) \land (r \land p)$	De Morgan's Law
$(\neg p \lor \neg r \lor \neg s) \land (r \land p)$	De Morgan's Law
$(\neg p \land (r \land p)) \lor (\neg r \land (r \land p)) \lor (\neg s \land (r \land p))$	Distributive Law
$((\neg p \land p) \land r) \lor ((\neg r \land r) \land p) \lor (\neg s \land r \land p)$	Commutative Law and Associative Law
$((c) \land r) \lor ((c) \land p) \lor (\neg s \land r \land p)$	Negation Law
$c \lor c \lor (\neg s \land r \land p)$	Identity Law
$(\neg s \land r \land p) \lor c \lor c$	Commutative Law
$((\neg s \land r \land p) \lor c) \lor c$	Associative Law
$(\neg s \land r \land p) \lor c$	Identity Law
$(\neg s \land r \land p)$	Identity Law
$p \land r \land \neg s$	Commutative Law

Therefore, since Sentence 1 is equal to Sentence 2, they are logically equivalent.

#49

a) Commutative Law
b) Distributive Law
c) Negation Law
d) Identity Law

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$((p \land (p \land \neg q)) (p \land q)$	By De Morgan's Law
$((p \land p) \land \neg q) \lor (p \land q)$	By Associative Law
$(p \land \neg q) \lor (p \land q)$	By Idempotent Law
$p \land (\neg q \lor q)$	Distributive Law
$p \land (q \lor \neg q)$	Commutative Law
$p \land t$	Negation Law
p	Identity Law