DM HOMEWORK 3 (12 февраля 2016 г.)

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Problem 1.
Write negations for each of the following statements:

A - John is six feet tall
B - John weights at least 200 pounds
$A \wedge B$ - John is six feet tall and he weighs at least 200 pounds
$\sim (A \wedge B) = \sim A \vee \sim B$
John is not six feet tall or he don't weighs at least 200 pounds.

A - The bus was late
B - Tom's watch was slow
$A \vee B$ - The bus was late or Tom's watch was slow
$\sim (A \vee B) = \sim A \wedge \sim B$
The bus was not late and Tom's watch was not slow

Problem 2.

$(\sim p \vee q) \to \sim q$

p	q	$\sim p$	$\sim p \vee q$	$\sim q$	$(\sim p \vee q) \to \sim q$
1	1	0	1	0	0
1	0	0	0	1	1
0	1	1	1	0	0
0	0	1	1	1	1

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

p	q	r	$\sim p$	$\sim p \wedge q$	$\sim r$	$(\sim p \wedge q) \to \sim r$
1	1	1	0	0	0	1
1	1	0	0	0	1	1
1	0	1	0	0	0	1
1	0	0	0	0	1	1
0	1	1	1	1	0	0
0	1	0	1	1	1	1
0	0	1	1	0	0	1
0	0	0	1	0	1	1

Problem 3.
p: Grizzly bears have been seen in the area.
q: Hiking is safe on the trail.
r: Berries are ripe along the trail.

- Berries are ripe along the trail, but grizzly bears have not been seen in the area. $r \wedge \sim p$
- Grizzly bears have not been seen in the area and hiking on the trail is safe, but berries are ripe along the trail. $\sim p \wedge r \wedge r$
- If berries are ripe along the trail, hiking is safe if and only if grizzly bears have not been seen in the area. $r \to (q \leftrightarrow p)$

Problem 4.

- 101 1110, 010 0001
  $1011110 \vee 0100001 = 1111111$
  $1011110 \wedge 0100001 = 0000000$
  $1011110 \oplus 0100001 = 1111111$

- 1111 0000, 1010 1010
  $11110000 \vee 10101010 = 11111010$
  $11110000 \wedge 10101010 = 10100000$
  $11110000 \oplus 10101010 = 01011010$

Problem 5.

Given any statement form, is it possible to find a logically equivalent form that uses only $\sim$ and $\wedge$?
Any logical formula can be represented in CNF with $\sim$, $\wedge$, $\vee$ operators only. Using De Morgan's low you can remove all $\vee$ operators.

Problem 6.

Disjunction is commutative.

p	q	$p \vee q$
1	1	1
1	0	1
0	1	1
0	0	0

p	q	$q \vee p$
1	1	1
1	0	1
0	1	1
0	0	0

Disjunction is associative.

p	q	r	$p \vee q$	$(p \vee q) \vee r$
1	1	1	1	1
1	1	0	1	1
1	0	1	1	1
1	0	0	1	1
0	1	1	1	1
0	1	0	1	1
0	0	1	0	1
0	0	0	0	0

p	q	r	$q \vee r$	$p \vee (q \vee r)$
1	1	1	1	1
1	1	0	1	1
1	0	1	1	1
1	0	0	1	1
0	1	1	1	1
0	1	0	0	1
0	0	1	1	1
0	0	0	0	0

Problem 7.

$\sim (p \wedge q) \neq \sim p \wedge \sim q$

p	q	$p \wedge q$	$\sim (p \wedge q)$
1	1	1	0
1	0	0	1
0	1	0	1
0	0	0	1

p	q	$\sim p$	$\sim q$	$\sim p \wedge \sim q$
1	1	0	0	0
1	0	0	1	0
0	1	1	0	0
0	0	1	1	1

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

p	q	$p \wedge q$	$\sim (p \wedge q)$
1	1	1	0
1	0	0	1
0	1	0	1
0	0	0	1

p	q	$\sim p$	$\sim q$	$\sim p \vee \sim q$
1	1	0	0	0
1	0	0	1	1
0	1	1	0	1
0	0	1	1	1

Problem 8.

Implication is logically equivalent to its contrapositive.

p	q	$p \to q$
1	1	1
1	0	0
0	1	1
0	0	1

p	q	$\sim q$	$\sim p$	$\sim q \to \sim p$
1	1	0	0	1
1	0	1	0	0
0	1	0	1	1
0	0	1	1	1

Converse is logically equivalent to the inverse.

p	q	$q \to p$
1	1	1
1	0	1
0	1	0
0	0	1

p	q	$\sim p$	$\sim q$	$\sim p \to \sim q$
1	1	0	0	1
1	0	0	1	1
0	1	1	0	0
0	0	1	1	1

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