HAWASSA UNIVERSITY
Collage of Natural and Computational Science
Department of Mathematics
Work sheet -1
Basic Mathematics for Natural Sciences   (2014EC)

1. Show that the following propositions are equivalent
   a) $(P \implies Q)$ and $\neg P \vee Q$ b) P and $P \wedge (Q \vee \neg Q)$

2. For statements p, q, and r, show that the following compound statements are tautology.
   a) $(p \wedge (p \implies q)) \implies q$.   b) $((p \implies q) \wedge (q \implies r)) \implies (p \implies r)$.

3. Let p and q be statements. Which of the following implies that $p \vee q$ is false?
   a. $\neg p \vee \neg q$ is false.   c. $p \implies q$ is true.
   b. $\neg p \vee q$ is true.   d. $p \wedge \neg q$ is true.

4. Suppose that the statements P, Q, R, and S are assigned the truth values T, F, F, and T, respectively. Find the truth value of each of the following statements
   (a) $R \implies (S \wedge P)$.   (c) $Q \wedge \neg S \implies (P \iff S)$.
   (b) $P \implies (R \implies S)$.   (d) $(R \wedge S) \implies (P \implies \neg Q \vee S)$

5. a) If the value of $P \implies Q$. is F, then what is the truth value of $(\neg P \wedge Q) \iff (P \vee Q)$?
   b) If the value of $P \iff Q$ is T, then what is the truth value of $P \iff \neg Q$ and $\neg P \iff Q$?
   c) If the value of $P \iff Q$ is F, then what is the truth value of $P \iff \neg Q$ and $\neg P \iff Q$?

6. Find the truth value of following compound statements using the given information.
   a) $(p \implies q) \implies r$, where $r = T$.   c) $p \vee (q \implies r)$, where $r = T$.
   b) $\neg(p \vee q) \iff (\neg p \wedge \neg q)$, where $p \vee q = T$.   d) $(p \implies q) \implies (\neg q \implies \neg p)$, where $q = T$.
   e) $(p \wedge q) \implies (p \vee s)$, where $p = T$.

7. Let $P(x, y): \frac{x}{y} < 1$. where the domain of x is $A = \{2, 3, 5\}$ and the domain of y is $B = \{2, 4, 6\}$. Then determine the truth value of the following quantified statement.
   a) $(\forall x \in A)(\exists y \in B) P(x, y)$.   b) $(\exists x \in A)(\exists y \in B) P(x, y)$.   c) $(\exists y \in B)(\forall x \in A) P(x, y)$

8. Determine the truth value of the following statements.
   a) $(\exists x \in \mathbb{R})(x^2 - x = 0)$.   e) $(\exists y \in \mathbb{R})(\exists x \in \mathbb{R})(x^2 + y^2 = 9)$.
   b) $(\forall x \in \mathbb{N})(x + 1 \geq 2)$.   f) $(\exists y \in \mathbb{R})(\forall x \in \mathbb{R})(x + y + 3 = 8)$
   c) $(\forall x \in \mathbb{R})(\sqrt{x^2} = x)$.   g) $(\forall x \in \mathbb{R})(\exists y \in \mathbb{R})(x + y = 5)$
   d) $(\exists x \in \mathbb{Q})(3x^2 - 27 = 0)$.   h) $(\exists x \in \mathbb{R})(\forall y \in \mathbb{R})(x + y = 5)$

9. Investigate the validity of the following argument forms using truth table method.
   a) $\neg p \implies \neg q, q \vdash p$.
   b) $p \implies \neg p, p, r \implies q \vdash \neg r$.   c) $p \implies q, \neg r \implies \neg q \vdash r \implies \neg p$.

10. Investigate the validity of the following argument forms using formal proof (rule of inference)
   a) $\neg p \implies \neg q, q \vdash p$.   c) $\neg r \wedge \neg s, (\neg s \implies p) \implies r \vdash \neg p$.
   b) $p \implies \neg q, p, r \implies q \vdash \neg r$.   d) $\neg q \implies \neg p, r \implies p, \neg q \vdash r$.   e) $p \implies q, \neg r \implies \neg q \vdash r \implies \neg p$.

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