

**Written Homework 1      Due: September 23, 2003 at the start of class**

1. Translate the following sentences containing  $A$  and  $B$  into sentences of English containing  $A$  and  $B$ . For example,  $\neg (A \vee B)$  can be translated ‘Neither  $A$  nor  $B$ ’.

(a)  $\neg (A \wedge B)$

(b)  $\neg (A \rightarrow B)$

(c)  $A \leftrightarrow \neg B$

(d)  $A \rightarrow (B \rightarrow A)$

(e)  $(A \rightarrow B) \rightarrow A$

2. Translate the following English sentences containing  $A$  and  $B$  to symbolic sentences containing  $A$  and  $B$ . For example, ‘Neither  $A$  nor  $B$ ’ can be translated as  $\neg A \wedge \neg B$ .

(a)  $A$  only if  $B$

(b) if  $A$ , then  $B$  only if  $A$

(c) if either  $A$  or  $B$  then  $B$

(d) not both  $A$  and  $B$

(e)  $A$  if and only if not  $B$

3. (Exercise 8, page 40 of Rosen) Translate the following statements into English, where  $R(x)$  is “ $x$  is a rabbit” and  $H(x)$  is “ $x$  hops” and the universe of discourse consists of all animals.

(a)  $\forall x (R(x) \rightarrow H(x))$

(b)  $\forall x (R(x) \wedge H(x))$

(c)  $\exists x (R(x) \rightarrow H(x))$

(d)  $\exists x (R(x) \wedge H(x))$

(e)  $\exists x (\neg R(x) \wedge H(x))$

4. (Like Exercise 20, page 41 of Rosen) Suppose that the universe of discourse of the propositional function  $P(x)$  consists of  $-3, -1, 1, 3$ . Express these statements without using quantifiers, instead using only negations, disjunctions, and conjunctions.

(a)  $\exists x P(x)$

(b)  $\forall x P(x)$

(c)  $\forall x ((x \neq 1) \rightarrow P(x))$

(d)  $\exists x ((x > 0) \wedge P(x))$

(e)  $\exists x (\neg P(x)) \wedge \forall x ((x < 0) \rightarrow P(x))$

5. (Disjunctive Normal Form) Do exercises 34, 35, and 36 on page 27 of Rosen. (Hint: The answer to 35 is in the back of the book.)