1. Translate each of the following into First-Order Logic

(a) For every problem there is a solution
(b) All men are fools
(c) No man is a fool
(d) Some women do not drink coffee
(e) Every student in the class has taken a course in calculus
(f) Every computer science student needs a course in logic.

For the remaining problems, assume the universe is CSCI531 students.

(g) There is a student in this class who owns a PC.
(h) Every student in this class has been in every building on campus.
(i) There is a student in CSCI531 who is a junior.
(j) Every student in CSCI531 is a CS major.
(k) There is a student in CSCI531 who is neither a mathematics major nor a junior.
(l) Every student in the class is either a sophomore or a CS major.

2. Give a one sentence English translation of each of the following FOL sentences. Note that a “quack” is a person who pretends to be a doctor.

(a) $\exists x \forall y \text{ Patient}(x) \land \text{Doctor}(y) \implies \text{Likes}(x,y)$
(b) $\forall x, y \text{ Patient}(x) \land \text{Quack}(y) \implies \neg\text{Likes}(x,y)$
(c) $\exists w \forall a \exists f \text{ Woman}(w) \land \text{HasTaken}(w,f) \land \text{FlownBy}(f,a)$

3. The expression $p \iff q$ is defined as being equivalent to $(p \implies q) \land (q \implies p)$. Based on this definition, show that $p \iff q$ is logically equivalent to $(p \lor q) \implies (p \land q)$. Do this two ways—by using truth tables, and by a series of substitutions using equivalency axioms.