**Tute -6**

Q1.Use De Morgan’s laws to find the negation of each of the following statements.

a) Jan is rich and happy.

b) Carlos will bicycle or run tomorrow.

Q2.

a) Show that ￢(p ⊕ q) and p ↔ q are logically equivalent.

b) Show that p ↓ p is logically equivalent to ￢p.

c) Show that (p ↓ q) ↓ (p ↓ q) is logically equivalent to p ∨ q.

Q3.Let C(x) be the statement “x has a cat,” let D(x) be the statement “x has a dog,” and let F(x) be the statement “x has a ferret.” Express each of these statements in terms of C(x), D(x), F(x), quantifiers, and logical connectives. Let the domain consist of all students in your class.

a) A student in your class has a cat, a dog, and a ferret.

b) All students in your class have a cat, a dog, or a ferret.

c) Some student in your class has a cat and a ferret, but not a dog.

d) No student in your class has a cat, a dog, and a ferret.

e) For each of the three animals, cats, dogs, and ferrets, there is a student in your class who has this animal as a pet.

Q4.Convert to English

a) ∀x IsABunny(x) ⇒ IsCute(x)

b) ∀x IsAStudent(x) ∧ IsTakingTFCS(x) ⇒ IsCool(x)

c) ∀x IsAPerson(x) ∧ IsAStudent(x) ∧ IsTakingTFCS(x) ⇒ IsCute(x) ∧ IsCool(x)

d) ∀x EatsRamen(x) ⇒ IsHomeless(x) ∨ IsAGradStudent(x)

e) ∃s ∀h IsAStudent(s) ∧ IsTaking(s,TFCS) ∧ HomeworkFor(h,TFCS) ∧ ¬Hates(s, h)

f) ∃p ∃time ∀base isACaptain(captain) ∧ isABase(base) ∧ <(time, Now) ∧ Owns(captain, base, time) ⇒ Owns(CATS, base, Now)

g) ∃x, y x=y

h) ∀x Loves(x, Snoopy) ⇔ ¬∃x ¬Loves(x, Snoopy)

i) ∀x, y FirstCousin(x, y) ⇒ ∃p, ps Siblings(ps, p) ∧ Parent(p, x) ∧ Parent(ps, y)

j) ∀x, y, s GradStudent(x) ∧ GradStudent(y) ∧ Watches(x, s) ⇒ Watches(y, s)

Q5.Convert to First-Order Logic

a) There is a bunny who is a cute.

b) Sister-in-law.

c) There is only one Elvis (do not use ∃!).

d) Every child who has a ID card is cool.

e) Some students took TfCS in Spring 2016 (using Take(person, course, semester)).

f) Every student who takes TfCS passes it.

g) Everybody loves everybody.

h) Everyone loves at least one person.

i) There is at least one person who loves everyone.

j) Any person can fool some of the people all of the time, all of the people some of the time but not all of the people all of the time.

k) All numbers are bigger than themselves divided by two.

l) Great-grandfather (define using three predicates).

m) Great-grandfather (define using one predicate; you can make other predicates).