Name: Sai Anish Garapati
UIN: 650208577

Assignment 9:

1) Propositional logic cannot be used to represent individual entities, while First order logic can be used better to represent the actual entities using objects, relations and functions.
Quantifiers such as forall and exists cannot be used in Propositional logic as opposed to first order logic. The use of quantifiers in First order logic helps in generalization of statements.

2) Universal Quantification in terms of Existential Quantification:
$\forall x \ F \ \equiv \ \neg \ \exists x \ \neg F$
Where F is a proposition that is true on x.

3)
a) Some students took CS411 in Spring2020:
Let:
student(x) : x is a student
CS411(x) : y is CS411 course
Spring2020(x): x is offered in Spring 2020
Takes(x, y): x takes y.

Then in first order logic:
$\exists x \ \exists y \ : \ student(x) \ \wedge \ CS411(y) \ \wedge \ Spring2020(y) \ \wedge \ Takes(x, y)$

b) Some students wear a hoodie with UIC logo on it:
Let:
student(x): x is a student
hoodie(x): x is a hoodie
UICLogo(x): x has UICLogo on it
wears(x, y): x wears y

Then in first order logic:
$\exists x \ \exists y \ : \ student(x) \ \wedge \ hoodie(y) \ \wedge \ UICLogo(y) \ \wedge \ wears(x, y)$

c) Something that glitters is not always gold, whereas gold always glitters:
Let:
gold(x): x is gold
glitters(x): x glitters

Then in first order logic:
$(\exists x \ : \ glitters(x) \ \wedge \ \neg gold(x)) \ \wedge \ (\forall y \ : \ gold(y) \ \implies \ glitters(y))$

d) No one can win with everyone all the time:
Let:
WinsWith(x, y): x wins with y
time(t): t is time

Then in first order logic:
$\neg \ \exists x \ \forall y \ \forall t \ : \ winswith(x, y) \ \wedge \ time(t)$

e) All CS courses are difficult, except two
Let:
CSCourse(x) : x is a CSCourse
difficult(x): x is difficult

Then in first order logic:

$$\exists y, z\ \forall x : CSCourse(y)\ \wedge\ CSCourse(z)\ \wedge\ CSCourse(x)\ \wedge \neg(y = z)\ \wedge\ \neg(x = y)\ \wedge\ \neg(x = z)\ \implies\ difficult(x)$$