**Experiment No:9**

**1) Represent the following sentences in first order logic (FOL)**

**a) Every person who buys a policy is smart**

**b) No person buys an expensive policy**

**c) There is an agent who sells policies only to people who are not insured d) There is a barber who shaves all men in town who do not shave themselves.** Answer:-

a) ∀x Person(x) ∧(∃y, z Policy(y) ∧Buys(x, y, z)) ⇒Smart(x)

b) ∀x, y, z Person(x) ∧Policy(y) ∧Expensive(y) ⇒￢Buys(x, y, z)

c) ∃x Agent(x) ∧∀y, z Policy(y) ∧Sells(x, y, z) ⇒(Person(z)∧￢Insured(z)) d) ∃x ∀y Barber(x) ∧Man(y) ∧￢Shaves(y, y) ⇒Shaves(x, y)

**2) Represent the following statements in FOPL.**

**a) If a perfect square is divisible by a prime p then it is also divisible by square of p**

**b) Every perfect square is divisible by some prime**

**c) If it is saturday and warm then john is in the park**

**d) Alice does not like chemistry and history**

**e) A square is breezy if there is a pit in the neighbouring square**

Answer:-

a) x [p (PerfectSquare(x) ^ Divisible(x,p)) ⇒ Divisible(x,p2)]

b) ∀x [∃p (PerfectSquare(x) ⇒ Divisible(x,p) ^ Prime(p)]

c) x (Saturday(x) ^ Warm(x) ⇒ IN(San, Park))

d) Likes(Alice, Chemistry) ^ Likes(Alice, History)

e) Square s = [x, y]

Predicates: Pit(s), Breezy(s), Adjacent(s, r)

FOPL: ∀s Breezy(s) ⇔ ∃r (Adjacent(r, s) ∧ Pit(r))

**3) Consider the following axioms**

**a) All people who are graduating are happy**

**b) Happy people smile**

**c) Someone is graduating**

**Represent this axioms in fol**

**Convert each formula to CNF**

**Prove someone is smiling using resolution technique Draw**

**the resolution tree**

**Represent these axioms in first order predicate logic.**

Object Constant: x = people

Predicates: G(x) = People Graduating, H(x) = Happy People, S(x) = Smiling People FOPL: ∀xG(x)∀H(x)

∀xH(x)∀S(x)

∃xG(x)OR∀xG(f(x))≈G(y)

**Convert each formula to clause form.**

Rules(axioms) : ∀xG(x)∀H(x);CNF:¬G(x)vH(x)

∀xG(x)∀H(x);CNF:¬G(x)vH(x)

Fact: ∀xG(x)SkolemizedasG(y)

Clause Forms:∃x¬Graduating(x)vHappy(x)

∀x¬Happy(x)vSmiling(x)

∃xGraduating(x)

**Prove that ‘’is someone smiling?’’ using resolution technique. Draw the resolution tree.**

Goal : ¬∃ x Smiling(x) (Negating the Conclusion)

= ∀ x ¬ Smiling(x) //Reduce scope of negation

**Resolution : Standardize variables apart**

∀ x ¬Graduating(x) v Happy(x)

∀ y ¬Happy(y) v Smiling(y)

∃ z Graduating(z) : Graduating(someone) // Eliminate

∀ w ¬ Smiling(w)

Drop all ∀

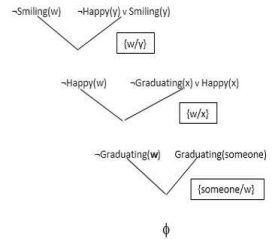
¬Graduating(x) v Happy(x)

¬Happy(y) v Smiling(y)

Graduating(someone)

¬ Smiling(w)

**Resolution Tree:**

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**4) Consider the following facts**

**a) It is a crime to sell weapons to enemies of america**

**b) Country nono is the enemy of the america**

**c) Nono has some missiles**

**d) All the designs were sold to nono by colonel west**

**e) Colonel west is an american**

**Prove that colonel is a criminal using forward and backward techniques**

Let’s see how to represent these facts by FOL.

It is a crime for an American to sell weapons to the enemy nations. American (x) ^Weapon(y) ^ sell (x.y.z) ^ enemy (z, America) => Criminal(x). Country Nono is an enemy of America.

Enemy (Nonk, America)

Nono has some missiles.

Owns (Nono, x)

Missile(x)

All the missiles were sold to Nono by Colonel West.

Missile(x) ^ owns(Nono,x) => Sell(West,x, Nono)

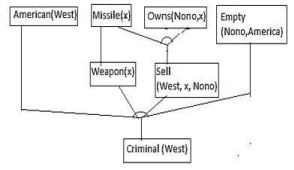
Missile is a weapon.

Missile(x)=> weapon(x)

Colonel West is American.

American (West).

Proof by forward chaining: The proof will start from the given facts. And we can derive other facts from those, it will lead us to the Solution.



Proof by backward chaining: This proof will start from the fact to be proved. And we can map it with given facts, it will lead us to the solution. As from e.g. we observe all leaf nodes of proof are given facts that mean ”West is Criminal”.

