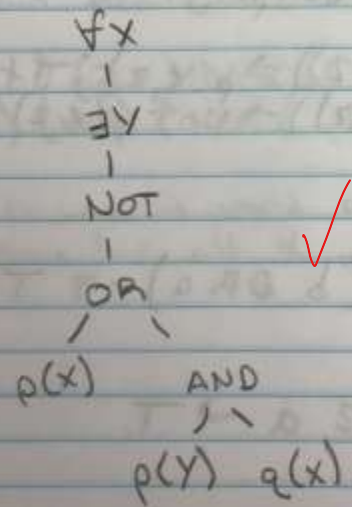
80

1) a) Variable
b) constant
c) constant
d) constant
e) non-ground atomic formula
f) ground atomic formula
g) constant

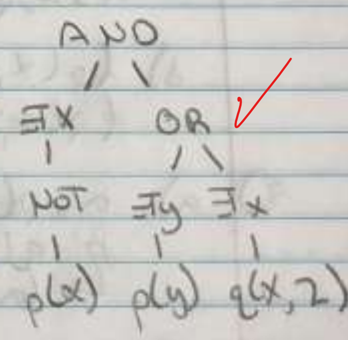
2) csg("CMPT220", S, G) AND snap(S, "L. Van Pelt", A, P) → answer(G)
c = "CMPT220"
n = "L. Van Pelt"

3) a) $(\forall X)(\exists Y)$ NOT (p(X) OR p(Y) AND q(X))
b) $(\exists X)$ NOT p(X) AND (($\exists Y$) p(y) OR ($\exists X$) q(X, Z))

4) a)



b)



5) $(\exists x)$ NOT $p(x)$ AND $((\exists y) p(y)$ OR $\forall V\, q(V, Z))$

6) a) $\forall E$ csg (c, s, "A") AND
snap(s, "C. Brown", A, P)
→ ("A")

-2

-1

b) NOT $(\exists c)$ csg (c, s, "A") AND
snap(s, "C. Brown", A, P)
→ ("A")

7) a) $(\forall x)(\exists y)(\text{loves}(x,y))$: T which domain?
$(\forall x)(\forall y)(\text{loves}(x,y))$: F

b) $p(x) = F$: $p(x) \rightarrow$ NOT $p(x)$: T -4
$p(x) = T$: $p(x) \rightarrow$ NOT $p(x)$: F

c) $(\exists x)\, p(x) \rightarrow (\forall x)\, p(x)$: T
$(\exists x) p(x) \rightarrow$ NOT$(\forall x) p(x)$: F

d) $(p(x,y)$ AND $p(y,z)) \rightarrow p(x,z)$: T
$(p(x,y)$ AND $p(y,z)) \rightarrow$ NOT $p(x,z)$: F

8) a) a: $p(x)$
b: $q(x)$ commutative law
↳ (a OR b) ≡ (b OR a) → T

b) a: $p(x,y)$ Idempotence law ✓
↳ (a AND a) ≡ a → T

c) a: $p(x)$ implication with AND and OR
↳ (a → FALSE) ≡ NOT a → T

9) a) $(\exists x)(\text{NOT } p(x))$ AND$((\exists y)\, p(y)))$ OR $\exists M\, q(M, z)))$

b) $(\exists x)(p(x)$ OR $q(x)$ OR $r(x))$ -2

10) a) $(\forall x)(\forall y)(p(x,y)$ OR $p(y,x))$ -1

b) $(\exists x)((\forall y)(p(x,y)$ OR $p(y,x)))$

11) Yes, because the law asserts that the quantifier $\exists x$ would apply to both $p(x,y)$ and $q(x)$ -4

12) a) $(\exists x)(\exists y)\, \exists M\, ($NOT $p(x)$ AND $p(y))$ OR $q(M,z))$ -1

b) $(\exists x)(\exists y)\, p(y)$ OR $q(x)$ OR $r(x)$

13) $(\overline{Q_1 x})(Q_2 y)(E \to F)$, E and F cannot contain free variables -1

14) a) $(\forall x)(\forall y)$ NOT $p(x,y)$

b) $(\forall x)(\forall y)($NOT$(p(x)$ OR $q(x,y))$ ✓

15) Yes, because it would assume there is a tautology for all x in E X -4