
**Question 1** (10%)
Use equivalences to construct a prenex normal form for the following wff. Show your work. Write down the number of the equivalence used at each step.
\[ \forall x \forall y (\exists z (p(x, z) \land p(z, y)) \rightarrow g(x, y)) \]

**Question 2** (10%)
Use equivalences to construct a prenex disjunctive normal form for the following wff. Show your work. Write down the number of the equivalence used at each step.
\[ \forall x \exists y p(x, y) \rightarrow \exists y \forall x p(x, y) \]

**Question 3** (20%)
Use equivalences to construct a prenex conjunctive normal form for the following wff. Show your work. Write down the number of the equivalence used at each step.
\[ \forall x \forall y \forall z (p(x, y) \land p(y, z) \rightarrow p(x, z)) \land \forall x \neg p(x, x) \rightarrow \forall x \forall y (p(x, y) \rightarrow \neg p(y, x)) \]

**Question 4** (20%)
Read the Logic Programming section in textbook. Use the following tree information (instead of the data given in the text):
- \( p(a, c) \)
- \( p(b, c) \)
- \( p(c, e) \)
- \( p(d, e) \)
- \( p(c, f) \)
- \( p(d, f) \)
- \( p(e, h) \)

(a) Draw the tree representation of the above data
(b) Consider the grand parent rule given in the text. Write down the steps that PROLOG will follow in the execution of the query
\[ ?- g(U, f). \]
for the above data.
(c) Write down rules for “ancestor”.
(d) [THIS IS NOT PART OF THE ASSIGNEMENT] I encourage you to download a PROLOG system, and try your ancestor rule on the above data (for example, you can write a query to list ancestors of \( h \) - or descendents of \( b \)).

Note: Total for this assignment is 60.