Final exam, cs580–002 (12/17/98, 4:30pm–7:15pm)

Your name:

Please hand print your answers. If I cannot read it I will assume it is wrong.

1. (15p) Explain how would you set up a hierarchical search procedure for the following graph. It is desired to find a path from any node in the graph to the node marked “Goal”.

![Graph Diagram]
2. (30p) Consider the following game tree.

(a) (10p) Find the best move for the MAX player using the minimax procedure.

(b) (10p) Perform a left-to-right alpha-beta pruning on the tree. Indicate where the cutoffs occur.

(c) (10p) Perform a right-to-left alpha-beta pruning on the tree. Discuss why different pruning occurs.
3. (5p) We represent the statement that everything is representable in the predicate calculus as $\forall x,\text{represents}(pc, x)$. General Problem Solver (GPS) is a system for automated problem solving. We represent the statement that all problems representable in predicate calculus are solvable using GPS as $\forall x, (\text{problem}(x) \land \text{represents}(pc, x)) \supset \text{solves}(gps, x)$. Now using these two statements and the fact that the Traveling Salesperson Problem (TSP) is a problem ($\text{problem}(tsp)$), prove that GPS solves it.

4. (10p) Attempt to unify the following pairs of expressions. Either show their most general unifiers or explain why they will not unify.

(a) $p(X,Y)$ and $p(a,Z)$
(b) $p(X,X)$ and $p(a,b)$
(c) $\text{ancestor}(X,Y)$ and $\text{ancestor}(\text{bill}, \text{father}(\text{bill}))$
(d) $\text{ancestor}(X, \text{father}(X))$ and $\text{ancestor}(\text{david}, \text{george})$
5. (25p) Sam, Clyde, and Oscar are rabbits. We know the following facts about them:

1. Sam is pink.
2. Clyde is gray and likes Oscar.
3. Oscar is either pink or gray (but not both) and likes Sam.

Use resolution refutation to prove that a gray rabbit likes a pink rabbit; that is, prove $(\exists x, y)[\text{Gray}(x) \land \text{Pink}(y) \land \text{Likes}(x, y)]$. 

6. (25p) The function \( \text{cons}(x, y) \) denotes list formed by inserting the element \( x \) at the head of the list \( y \). We denote the empty list by \( \text{Nil} \); the list (2) by \( \text{cons}(2, \text{Nil}) \); the list (1, 2) by \( \text{cons}(1, \text{cons}(2, \text{Nil})) \); and so on. The formula \( \text{Last}(l, e) \) is intended to mean that \( e \) is the last element of the list \( l \). We have the following axioms:

\[ - (\forall u)[\text{Last}(\text{cons}(u, \text{Nil}), u)] \]
\[ - (\forall x, y, z)[\text{Last}(y, z) \supset \text{Last}(\text{cons}(x, y), z)] \]

1. Prove the following theorem from these axioms by the method of resolution refutation:

\[ (\exists v)[\text{Last}(\text{cons}(2, \text{cons}(1, \text{Nil})), v)] \]

2. Use answer extraction to find \( v \), the last element of the list (2, 1).