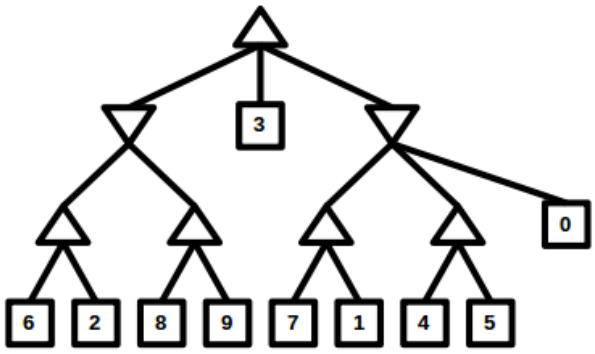
CSci 4511
Final

Name: _____

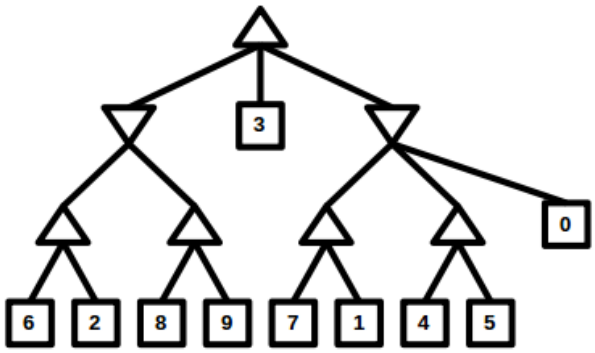
Student ID: _____

Instructions: The time limit is 120 minutes. Please write your answers in the space below. If you need more space, write on the back of the paper. The exam is open book and notes. You may not use the internet or any other outside resources. Usage of phones during the test is not allowed. For all questions you must **show work** to receive full credit.

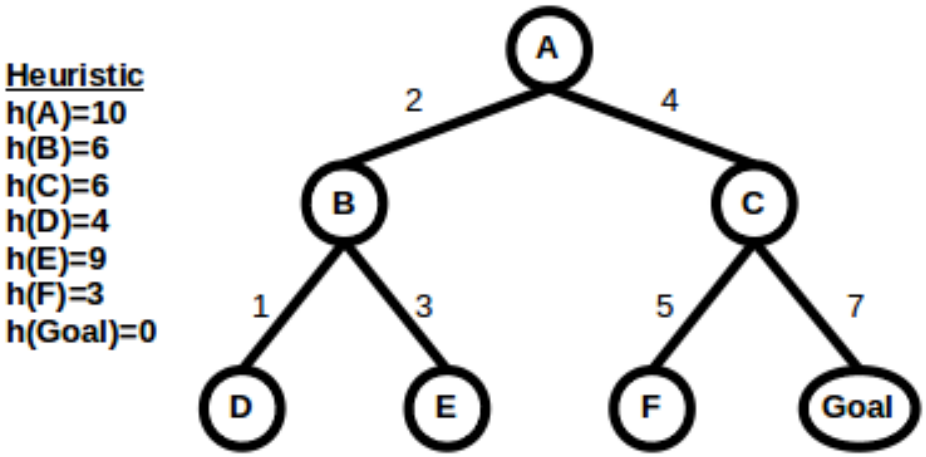
Problem (1) [15 points]
Consider the minimax tree shown below (triangles pointed upwards are "max" nodes). (1) Show which nodes can be pruned if the search (DFS) goes left-to-right. (2) Show which nodes can be pruned if the search (DFS) goes right-to-left.
(1) Left-to-right



(2) Right-to-left



Problem (2) [15 points]
Perform iterative deepening A* search on the following tree. Make sure to show enough work so that it is clear the order you expand nodes.



Problem (3) [15 points]
Below are four sentences ($\alpha = alpha, \beta = beta, \gamma = gamma, \delta = delta$) with their valid models listed. (1) Show all possible entailments of the form $x \models y$, where x and y are one of the four sentences (without ANDing, ORing, or combining sentences together). (2) Find two other entailments that involve at least three of the sentences and an AND and/or OR (for example, $x \wedge y \models z$ or $x \models y \vee z$). On both of these parts, do not answer with trivial entailments, such as: $\alpha \models \alpha$.

α :
(A, B, C)
$(A, B, \neg C)$
$(A, \neg B, C)$

β :
$(A, B, \neg C)$
$(A, \neg B, C)$
$(\neg A, B, C)$
$(\neg A, \neg B, \neg C)$

γ :
$(A, B, \neg C)$
$(A, \neg B, C)$

δ :
$(A, B, \neg C)$
$(\neg A, B, C)$

Problem (4) [15 points]
Convert the following English sentences to first order logic:
(1) "No matter how good you are, there is always someone better"
(2) "I study for my finals, unless it is an easy class"
(3) "I only do my homework the night before it is due"

Problem (5) [15 points]
Consider the KB below in CNF. Use resolution to determine if $KB \models \exists x, y\ E(x) \wedge C(y, x)$. (Clearly show unifications/substitutions.)
KB:
$\neg A(x) \vee B(f(x))$
$\neg A(x) \vee C(x, f(x))$
$\neg B(x) \vee D(x)$
$\neg D(x) \vee B(x)$
$\neg D(x) \vee E(x)$
$\neg D(x) \vee F(x)$
$A(Cat)$
$E(Dog)$
$F(Dog)$

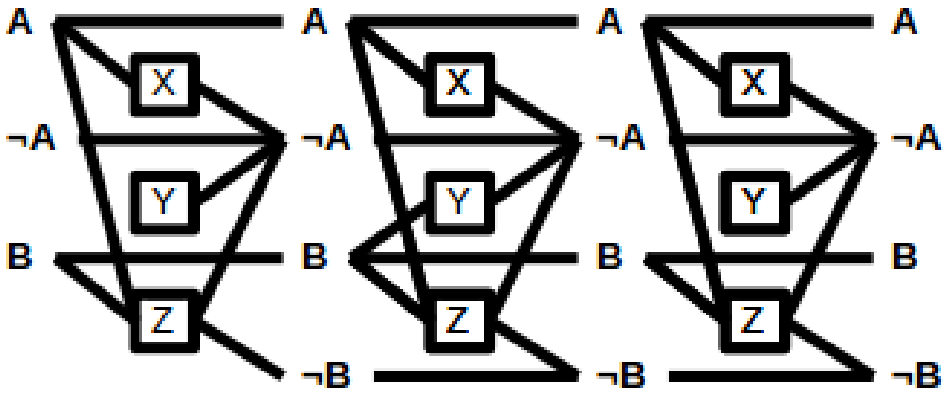
Problem (6) [10 points]
Consider the Money/Smart/Debt problem we did in class below. Suppose your initial state is $(S \wedge \neg M \wedge D)$ and your goal is $(\neg D)$. Do a forward search using A^* to search the tree for the goal. Clearly show or describe how you are generating the heuristic value for each state.

$Action(School,$
$Preconditions:,$
$Effects: D \wedge S)$

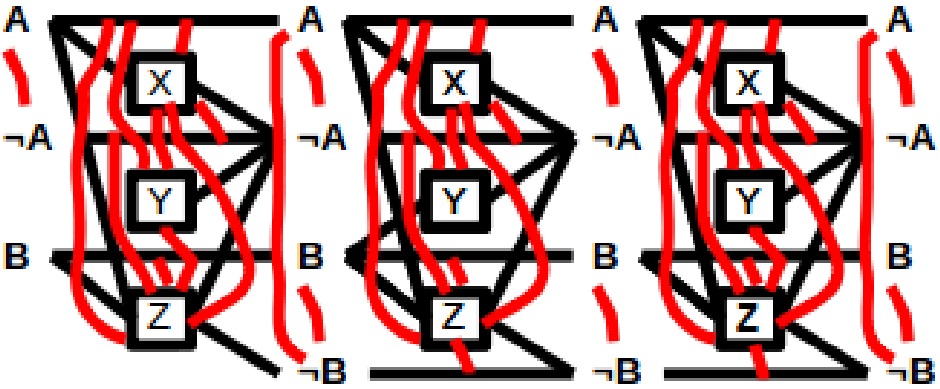
$Action(Job,$
$Preconditions:,$
$Effects: M \wedge \neg S)$

$Action(Pay,$
$Preconditions: M,$
$Effects: \neg M \wedge \neg D)$

Problem (7) [15 points]
Find 3 errors in the following graphplan along with a justification why it is an error. These errors must be unrelated (i.e. if the error is fixed (everywhere possible if it is a general error), (1) your other answers must still be errors and (2) you cannot claim an additional error on anything your 'fix' caused that was not originally an error).
No mutexes:



With mutexes:



Mutex list:
State 0: $(A, \neg A)$
Action 1: $(X, Y), (X, Z), (X, A), (X, \neg A), (Y, Z), (Y, A), (Z, A), (Z, \neg A), (Z, B)$
State 1: $(A, \neg A), (B, \neg B), (A, \neg B)$
Action 2: $(X, Y), (X, Z), (X, A), (X, \neg A), (Y, A), (Z, A), (Z, \neg A), (Z, B), (Z, \neg B)$
State 2: $(A, \neg A), (B, \neg B)$
Action 3: $(X, Y), (X, Z), (X, A), (X, \neg A), (Y, Z), (Y, A), (Z, A), (Z, \neg A), (Z, B), (Z, \neg B)$
State 3: $(A, \neg A), (B, \neg B), (A, \neg B)$