1. (25 pts) Consider a tree with branching factor $b$ and the optimal goal state at depth $d$ (root is at depth 0).

   (a) Describe the four criteria used for evaluating the different search algorithms.

   (b) Discuss breadth-first search and depth-first search for each of the four criteria.

   (c) For each of the two algorithms, discuss in what situation you would choose one algorithm over the other.
2. (25 pts) On predicate logic:

(a) Consider the sentence “All students study AI.” For each of the following logical sentences, state if it is a correct or incorrect translation and explain why it is correct/incorrect.
   i. $\forall x \text{Student}(x) \land \text{Study}(x, AI)$
   ii. $\forall x \text{Student}(x) \Rightarrow \text{Study}(x, AI)$

(b) Consider the sentence “One student studies AI.” For each of the following logical sentences, state if it is a correct or incorrect translation and explain why it is correct/incorrect.
   i. $\exists x \text{Student}(x) \land \text{Study}(x, AI)$
   ii. $\exists x \text{Student}(x) \Rightarrow \text{Study}(x, AI)$

(c) Explain if the following two logical sentences are the same or different in meaning (semantic):
   i. $\exists x \forall y \text{Study}(x, y)$
   ii. $\forall y \exists x \text{Study}(x, y)$

(d) Explain if the following two logical sentences are the same or different in meaning (semantic):
   i. $\neg \forall x \neg \text{Study}(x, AI)$
   ii. $\exists x \text{Study}(x, AI)$
3. (25 pts) Consider a theorem prover application. The A* algorithm can be used to search for the simplest (shortest) proof. Assume that the known axioms and theorems are represented as a knowledge base of Horn clauses in propositional logic, and that the prover uses Backward Chaining.

(a) Propose an admissible heuristic.
(b) Prove that the proposed heuristic is admissible.
4. (25 pts) Given the following mini-max tree:

```
     *  
   /a  |b  \c
   *  
  /d  |e  \f  
  *  
  /g  |h  \i  
  *  
  /j  |k  \l

1 5 10 2 3 4 0 8 3
```

(a) What is the next move?
(b) Would alpha-beta pruning reduce the number of visited nodes? Explain.