Answer all SEVEN questions. Each question carries equal weight. Clear and detailed answers are expected. Points will be deducted for incorrect reasons and statements. Expect no credit if you give two contradictory answers for the same question.

1. (a) Define the 'frame problem'.
   (b) Define 'inductive learning'.
   (c) Define 'factoring' (in the context of resolution theorem proving).

2. Comment on the following statements:
   (a) Computation using certainty factors corresponds to probabilistic reasoning.
   (b) Simulated annealing is the best choice for every global optimization problem.
   (c) The perceptron algorithm is guaranteed to terminate, giving results that may not always be acceptable.

3. (a) What is the advantage of using genetic algorithms when compared to heuristic search methods such as the A* algorithm?
   (b) Give a simple example to demonstrate the usefulness of alpha-beta search.
   (c) Use a semantic network to represent the sentence:
   Bangenapally mangoes are fleshier than Rasaalu mangoes, but less juicy.

4. R is a binary relation that is irreflexive, i.e., $R(x, x)$ is always false. R is also transitive. Use the resolution refutation theorem-proving method to show that R cannot have a 3-element cycle, i.e., it can never be the case that $R(x, y)$ and $R(y, z)$ and $R(z, x)$. If needed, state and use appropriate clauses or inference rules for the equality predicate.

   Can this method (resolution refutation) be used to show that R cannot have any cycle, i.e., that there is no sequence of elements such that

   (i) R relates successive elements in that sequence, and
   (ii) R also relates the last and first elements in that sequence?

5. Design a system to recognize human faces from black-and-white photographs. Describe the representation scheme as well as details of the face recognition procedure.

6. Discuss (in detail) how the following "menu selection" problem may be solved, in the light of the AI techniques you have studied.

   > A group of very hungry people have to select what to eat at a restaurant. Each member of the group has his/her preferences among menu choices. Each item on the menu has its own price. Unfortunately, they do not have enough money between them to pay for each person's first choice.

   Illustrate your method on a small example.

7. Several different grammars are given below, all with the same vocabulary. S is the start (or 'Sentence') symbol, all uppercase characters are nonterminals, and lowercase characters are terminals.

   (a)
   $$S \to A\ P,\quad P \to P\ P,\quad A \to a,\quad P \to b$$

   (b)
   $$S \to A\ P,\quad P \to A\ P,\quad A \to a,\quad P \to b$$

   (c)
   $$S \to A\ P,\quad A \to A\ P,\quad A \to a,\quad P \to A\ P,\quad P \to b$$

   - For each of these grammars, say whether the grammar is ambiguous or unambiguous. Either way, justify your answer.
   - If any of these grammars is ambiguous, construct an equivalent grammar that recognizes the same language but is unambiguous.
   - In parsing, what is the advantage of knowing that a grammar is unambiguous?