Q.1  
\[ a. \] One of the results to come out of the first three decades of AI research is that intelligence requires knowledge. What disadvantages does knowledge possess?  

\[ b. \] What properties should be possessed by a knowledge representation system?  

\[ c. \] Consider the following function of two variables:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>Desired Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Prove that this function cannot be learned by a single perceptron that uses the step function as its activation function.  

\[ d. \] Describe the salient features of an agent.  

\[ e. \] State the conditions under which A* is admissible.  

\[ f. \] Compare and contrast declarative and procedural knowledge.  

\[ g. \] What are constraint satisfaction problems (CSPs)? State N-queen problem as CSP.  

\[ (7 \times 4) \]

Q.2  
\[ a. \] Given a full 5-gallon jug and an empty 2-gallon jug, the goal is to fill the 2-gallon jug with exactly one gallon of water. You may use the following state space formulation.  
State = (x,y), where x is the number of gallons of water in the 5-gallon jug and y is number of gallons in the 2-gallon jug  
Initial State = (5,0)  
Goal State = (*, 1), where * means any amount  
Create the search tree. Discuss which search strategy is appropriate for this problem.  

\[ (10) \]
b. Consider a knowledge base $KB$ that contains the following propositional logic sentences:
\[ Q \Rightarrow P \]
\[ P \Rightarrow \neg Q \]
\[ Q \vee R \]

(i) Construct a truth table that shows the truth value of each sentence in $KB$ and indicate the models in which the $KB$ is true.

(ii) Does $KB$ entail $R$? Use the definition of entailment to justify your answer.

(iii) Does $KB$ entail $R \Rightarrow P$? Extend the truth table and use the definition of entailment to justify your answer.

(iv) Does $KB$ entail $Q \Rightarrow R$? Extend the truth table and use the definition of entailment to justify your answer.

Q.3

a. What is an expert system? Discuss different problems solved by expert systems.

b. Given the following information in a database
A1: If x is on top of y, y supports x.
A2: If x is above y and they are touching each other, x is on top of y.
A3: A cup is above a book.
A4: A cup is touching a book.

(i) Translate statements A1 through A4 into clausal form.

(ii) Show that the predicate support (book, cup) is true using resolution.

(c. Discuss various applications of Genetic Algorithm (GA).

Q.4

a. Construct a partitioned net: Every parent loves child

b. Explain minimax algorithm with alpha-beta pruning. Show alpha-beta pruning on the following minimax graph.
Q.5  
a. Construct by hand a perceptron that can calculate the logic function implies (=>).  
Assume that 1 = true and 0 = false for all inputs and outputs.  (8)

b. Discuss goal stack planning using the following initial and goal state.  (10)

```
Start: B C A D
Goal: C A B D
```

Q.6  
a. Consider the following Context free Grammar for English

(i)  S->NP, VP_PPS
(ii) NP->DET, ADJS_NOUN
(iii) ADJS_NOUN->ADJ, ADJS_NOUN
(iv) ADJS_NOUN->NOUN
(v)  VP_PPS-> VP_PPS, PP
(vi) VP_PPS->VP
(vii) VP->VERB, NP
(viii) PP->PREP, NP
(ix)  DET->a/the/this/that
(x)  ADJ->silly/red/big
(xi)  NOUN->robot/pyramid/top/table/telescope
(xii) VERB->moved
(xiii) PREP->to/of/on/with

Give bottom-up parser (sequence of rules used) for the following sentence:
"the silly robot moved the pyramid to the big table"  (10)

b. Given the rule base
  If (cloudy) then (rain), C.F.=0.7
  If (warm) and (early summer) then (rain), C.F.=0.9
  If (sunny) then (warm), C.F.=0.8

And the facts
  cloudy with C.F.=0.4
  sunny with C.F.=0.7
  early summer with C.F.=0.9

Calculate C.F.(rain).  (8)

Q.7  
Write a brief note on FOUR of the following:

(i)  Hopefield Network
(ii) A general genetic algorithm
(iii) Agent Architecture
(iv) Explanation module in Expert System Architecture
(v)  Bayesian Belief Network  (4.5 x 4)