Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech (ECE)/SEM-2/MCE-204B/2013

2013

ARTIFICIAL INTELLIGENCE & SOFT COMPUTING

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer Question No. **1** and any *four* from the rest.

1. a) Give McCulloch-Pitts model for artificial neurons.

   b) Give the X-projection and Y-projection of :

$$\mu_R(x, y) = \begin{pmatrix} 0\cdot1 & 0\cdot5 & 0\cdot2 \\ 0\cdot9 & 0\cdot7 & 0\cdot1 \\ 0\cdot3 & 0\cdot5 & 0\cdot6 \end{pmatrix}$$

   c) Prove : $p \rightarrow (q \rightarrow r) \Rightarrow (p \Rightarrow q) \Rightarrow r$ where p, q and r are three propositions.

   d) A box contains 10 screws, out of which 3 are defective. Two screws are drawn at random. Find the probability that name of the two screws are defective using :

      i) Sampling with replacement

      ii) Sampling without replacement.

e) What is the difference between BFS and DFS search techniques ?

f) Solve for (X_1, X_2) with the help of 'problem-decomposition and constraint-satisfaction' approach.
Given : $X_1 \geq 2$, $X_2 \geq 3$, $X_1 + X_2 \leq 6$, $X_1, X_2 \in I$

3 + 2 + 2 + 3 + 2 + 2

2. a) With reference to a typical production system, what is 'Recognise-Act Cycle' ?

b) Why are conflict resolution strategies required in production systems ? Outline the various conflict resolution strategies.

c) Prove :

i) $p \rightarrow q \equiv \urcorner p \vee q$

ii) $p \rightarrow q \Rightarrow \urcorner q \rightarrow \urcorner p$.

3 + 6 + 5

3. a) What is resolution theorem ?

b) Prove the resolution theorem using Wang's algorithm.

c) Prove that Dog (fido) follows from the following statements by resolution theorem.

i) $\forall X$ Barks (X) $\rightarrow$ Dog (X)

ii) $\forall X \forall Y \exists Z$ Has-master (X, Y) $\wedge$ Likes (X, Y) $\wedge$ Unprecedented situation (Z) $\rightarrow$ Barks (X)

iii) Unrecedented-situation (noise)

iv) Likes (fido, jim)

v) Has-master (fido, jim). 2 + 5 + 7

4. a) Explain unsupervised learning with respect to artificial neural networks.

b) Briefly outline discrete hopfield net.

c) What is the difference between competitive leaning and Hebbian learning with respect to Artificial neural networks.

d) Outline two common topologies to be found in artificial neural networks. 5 + 5 + 2 + 2

5. a) Describe the process of genetic algorithm with the help of a simple schematic diagram.

b) Outline the optimization of function $f(x) = x^2 - 25$ with the help of Genetic Algorithm using a population of 5 chromosomes and 2 iterations.

c) Describe the process of differential evolution with the help of its schematic diagram. 5 + 4 + 5

6. a) Describe the perceptron learning algorithm along with a simple schematic diagram.

b) Outline the method for translational-invariance and rotational-invariance (90°, 180°, 270°) given by Widrow-Hoff with ADALINE neurons.

c) Construct :

i) Logical AND gate

ii) Logical OR gate with McCulloch-Pitts neurons.

5 + 6 + 3

7. a) Why is Fuzzy production system better than traditional production system ?

b) Outline any *three* Fuzzy implications rules.

c) For the given Fuzzy set :

$A = \{ x1/0{\cdot}2,\ x2/0{\cdot}4,\ x3/1,\ x4/0{\cdot}7,\ x5/0{\cdot}6,\ x6/0{\cdot}5,\ x7/0{\cdot}9,\ x8/0 \}$

Calculate the following :

i) Core (A)

ii) Support (A)

iii) Is A a 'normal' fuzzy-set ?

iv) α-cut $(A)|_{\alpha = 0{\cdot}6}$

v) α-cut $(A)^{+}|_{\alpha = 0{\cdot}6}$ (Strong α-cut).

d) PR1 : If age is YOUNG THEN digestion-rate is HIGH.

PR2 : If digestion-rate is HIGH THEN speed is HIGH.

Find μ_R (age, speed) if :

digestion-rate →

$$\mu_R \text{ (age, digestion-rate} = \;\; \downarrow \text{age} \begin{bmatrix} 0\cdot2 & 0\cdot3 & 0\cdot6 \\ 0\cdot4 & 0\cdot6 & 0\cdot5 \\ 0\cdot3 & 0\cdot6 & 0\cdot9 \end{bmatrix}$$

speed →

$$\mu_R \text{ (digestion-rate, speed)} = \;\; \downarrow \text{digestion-rate} \begin{bmatrix} 0\cdot8 & 0\cdot7 & 0\cdot5 \\ 0\cdot7 & 0\cdot7 & 0\cdot4 \\ 0\cdot7 & 0\cdot4 & 0\cdot5 \end{bmatrix}$$

2 + 3 + 5 + 4

8. a) Prove :

$$P\left(H_j / E_1, E_2, \ldots, E_m\right) = \frac{\prod_{i=1}^{m} P\left(E_i / H_j\right) P\left(H_j\right)}{\sum_{k=1}^{n} \prod_{i=1}^{m} P\left(E_i / H_k\right) P\left(H_k\right)}$$

for the Hypothesis space H consisting of H_j; $1 \le j \le n$ and evidence space consisting of E_i; $1 \le i \le m$.

b) Describe the process of Hill Climbing. What is the problem of 'trapping at local minima at a foothill' encountered in hill-climbing ?

c) Outline the process of simulated-annealing. How it overcomes the problem of 'trapping at local minima at a foothill' encountered in hill-climbing ? 7 + 3 + 4