M.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING 1st YEAR 1st SEMESTER - 2018

NEURO-FUZZY & EVOLUTIONARY COMPUTATION **Time: 3 hours** **Full Marks: 100**

Answer **Q.1 and any five** from the rest.

Q.1 a) State three limitations of the traditional Artificial Intelligence.
b) Differentiate between a fuzzy set and a conventional set.
c) Analyze whether $c(a) = (1-a)/(1+2a)$ is a fuzzy complementation.
d) What is meant by Generalized Modus Tollens?
e) Name one algorithm each in the categories of supervised learning, unsupervised learning and competitive learning.
f) Realize a 2-input AND function using McCulloch-Pitts neurons.
g) Justify the naming of the backpropagation algorithm.
h) State one limitation of the perceptron learning algorithm.
i) Mention the different steps in the cycle of Genetic Algorithm.
j) Find the crossover survival probability of a schema H = * 1110 * *. Assume that the cross-over is performed with a probability 0.1.

10 x 3

Q.2 a) Define fuzzy T-norm.
b) Analyze whether the Einstein product $T_{ep}(a,b) = ab/\{2-(a+b-ab)\}$ is a fuzzy T-norm.
c) Define fuzzy max-min composition and mention its properties.

4 + 4 + (2+4)

Q.3 a) What is meant by a fuzzy implication relation? Show Lukasiewicz and Mamdani implications.
b) Consider a fuzzy production rule: *IF height is TALL and weight is MODERATE THEN speed is HIGH*. Given: μ_{TALL}(height) = [0.5/5′, 0.8/6′, 1.0/7′], $\mu_{MODERATE}$(weight) = [0.7/45 kg, 0.9/50 kg.] and μ_{TALL}'(height) = [0.6/5′, 0.7/6′, 0.9/7′], $\mu_{MODERATE}'$(weight) = [0.8/45 kg, 0.7/50 kg.] and μ_{HIGH}(speed) = [0.6/6 m/s, 0.8/8 m/s, 0.5/9 m/s]. Obtain μ_{HIGH}'(speed). Use Lukasiewicz implication.

(3+3)+8

Q.4 a) Examine the suitability of Fuzzy C-Means (FCM) algorithm in pattern clustering.
b) Mathematically argue that the FCM algorithm actually solves a constrained optimization problem.
c) Derive the membership of the k^{th} data point (vector) in the FCM algorithm to belong to the i^{th} cluster A_i.

3+5+6

Q.5 a) Explain the importance of Lyapunov energy function for unsupervised learning.
b) Show by a suitable Lyapunov energy function that the following dynamics is stable:

$$\frac{dx_i}{dt} = -ax_i, i = 1, \dots, n; a > 0$$

c) State and explain the Theorems by Cohen-Grossberg and Cohen-Grossberg-Kosko on neural dynamics. No proof is necessary. 3+5+6

Q.6 a) Show how perceptrons can be employed to solve a pattern classification problem. Assume the patterns to be linearly separable.

b) Establish a proof of perceptron convergence in the context of the problem in (a).

c) Compare and contrast ADALINE and perceptrons.

5+6+3

Q.7 a) Explain the principle of gradient descent learning in the backpropagation algorithm.

b) Examine the suitability of i) a signum function, ii) a sigmoid function, and, a iii) tanh function for modeling the synaptic non-linearity of neurons in an artificial neural network in the context of the algorithm in (a).

c) Suggest an alternative learning strategy for the algorithm in (a).

4+6+4

Q.8 a) Explain any two stochastic operations pertinent to genetic algorithm.

b) Show how genetic algorithm can be applied to a medical image registration problem.

c) Consider a problem MINZERO where the goal is to minimize the number of zeroes in 5 bit strings each with 6 binary digits. Build an initial population in a random fashion. Suggest a suitable objective function and compute the fitness of the bit strings. Using proportional selection, compute the probabilities of these bit strings to be selected for the next population.

4+4+6