Dr Sushil Chauhay 28/11/2023

National Institute of Technology, Hamirpur (HP)

B. Tech. End-semester Examination

Branch: Open Elective (Offered by DoEE) Semester: 5th

Title of the Course: Artificial Neural Networks and Fuzzy Logic Systems

Course Code: EE-370

Time: 3 Hours **Maximum Marks: 50**

Note: Attempt any FIVE questions.

Q.1(a) Explain working of biological neuron and its mathematical model put forward by Mc Cullock and Pitts. (5)

(b) Derive delta learning rule of single neuron learning. (5)

Q.2 Consider Fig. 1 given below.

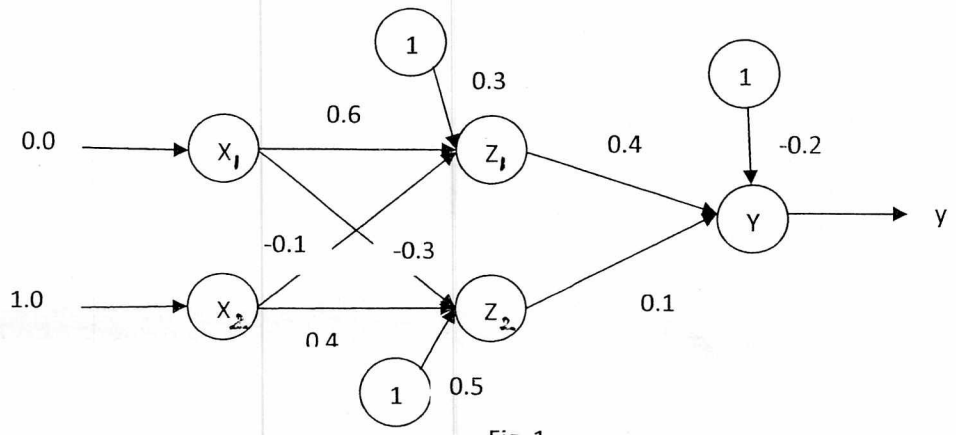


Fig. 1

Using error back-propagation learning technique, find new connection-weights and biases when nodes Y, Z_1 and Z_2 are equipped with bipolar sigmoidal function. Take learning rate, η as 0.25. Target output Y is 1.0. (10)

Q.3(a) Design radial basis function network (RBFN). How information is processed through it? Write steps to determine center and spread of activation function for hidden nodes. (5)

(b) Draw the architecture of neuro-fuzzy system and show how information is processed through this hybrid system. Also explain how learning can be incorporated in this model. (5)

Q.4(a) Draw architecture of Kohonen Self-organizing Feature map and give flow chart for its training. (5)

(b) What is PI-like fuzzy logic controller (FLC)? Write rule-base for its implementation. (5)

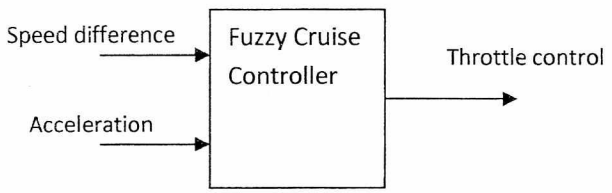
Q.5 (a) Derive a metric using Euclidian distance of order p to measure the fuzziness of a fuzzy set for finite and infinite universe of discourse, X. (5)

(b) Consider following fuzzy sets defined over common universe of discourse, $X = \{x_1, x_2, x_3, x_4, x_5\}$.

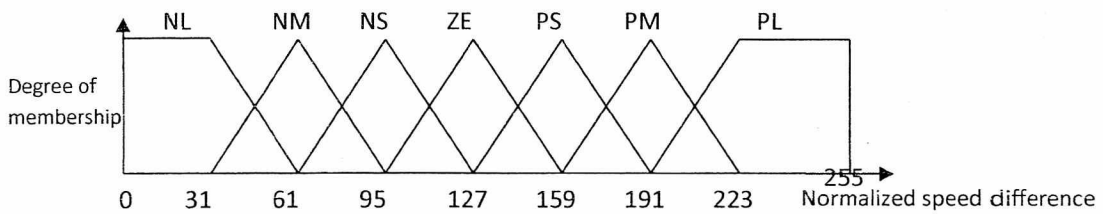
$A = \{1/x_1, 0.5/x_2, 0.3/x_3, 0.8/x_4, 0.9/x_5\}$; $B = \{1/x_1, 0.5/x_2, 0.3/x_3, 0.8/x_4, 0.9/x_5\}$. Find

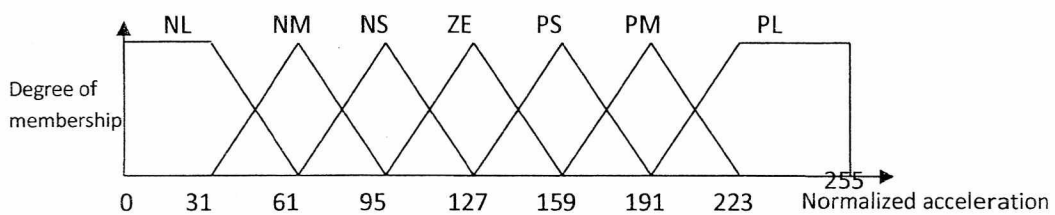
(i) CORE(A) (ii) FUZ(B) (iii) DIL(B) (iv) $A \oplus B$ (v) Prove that $\overline{|A \cup B|} = \overline{A} \cap \overline{B}$. (5)

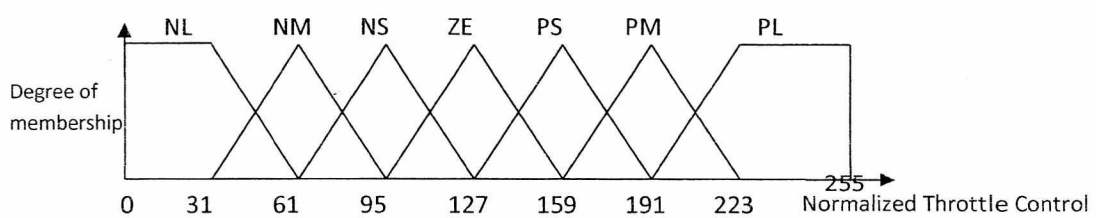
Q. 6 It is desired to maintain the Crusie at a desired speed. A Fuzzy Cruise Controller is designed with rule base and term-sets as under:



Fuzzy rule base governing the cruise control is given below:
Rule 1 If (speed difference is NL) and (acceleration is ZE) then (throttle control is PL)
Rule 2 If (speed difference is ZE) and (acceleration is NL) then (throttle control is PL)
Rule 3 If (speed difference is NM) and (acceleration is ZE) then (throttle control is PM
Rule 4 If (speed difference is NS) and (acceleration is PS) then (throttle control is PS)
Rule 5 If (speed difference is PS) and (acceleration is NS) then (throttle control is NS)
Rule 6 If (speed difference is PL) and (acceleration is ZE) then (throttle control is NL)
Rule 7 If (speed difference is ZE) and (acceleration is NS) then (throttle control is PS)
Rule 8 If (speed difference is ZE) and (acceleration is NM) then (throttle control is PM)







Calculate the throttle control for a speed difference of 100 and acceleration of 70. (10)