B.E. Instrumentation Engineering Seven Semester

Elective-I : IN 7044 - Neural Network And Fuzzy Logic

P. Pages : 3 **GUG/W/18/1832**

Time : Three Hours * 1 4 3 1 * Max. Marks : 80

Notes : 1. Same answer book must be used for each question.
2. All questions carry marks. as indicated .
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) Illustrate the functions of biological neuron. Discuss how artificial neuron models are inspired from biological neurons. **8**

b) Derive the weight update rule using delta learning rule. **8**

OR

2. a) Differentiate between: **8**

i) Hebbian Vs Perceptron learning rule

ii) Winner -Take- All Vs Outstar learning rule.

b) Draw and discuss the architecture of feed forward neural network. **8**

3. a) Define discriminant function. Also state it's properties. **4**

b) If $f(net) = \frac{2}{1+\exp(-net)} - 1$ with $\lambda = 1$ **4**

Then prove the following identify

$$f'(net) = \frac{1}{2}\left(1 - 0^2\right)$$

c) Elaborate the step-wise procedure for single continuous perceptron training algorithm to classify the given unknown patterns. **8**

OR

4. a) Illustrate the basic concept of pattern classifier with block diagram. **4**

b) Define a dichotomizer. Discuss how it is designed using neural network. **4**

c) Discuss in detail the procedure of design of linear machine to classify the given patterns into one of the R categories using minimum distance classification approach. **8**

5. a) Define the Extension principle applied to fuzzy sets. **4**

b) Distinguish between crisp logic and fuzzy logic. **4**

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c) The fuzzy sets $\underset{\sim}{A}$ and $\underset{\sim}{B}$ are defined on the universe $X = [0, 5]$, with the following membership functions. **8**

$$\mu_{\underset{\sim}{A}}(x) = \frac{1}{1+5(x-5)^2}\ ,\ \mu_{\underset{\sim}{B}}(x) = 2^{-x}$$

a) Sketch the membership functions.

b) Define the intervals along the x - axis corresponding to the λ - cut sets for each of the fuzzy sets $\underset{\sim}{A}$ and $\underset{\sim}{B}$ for the following values of λ:

i) $\lambda = 0.2$

ii) $\lambda = 0.6$

iii) $\lambda = 0.9$

iv) $\lambda = 1.0$

OR

6. a) How fuzzy sets are represented mathematically? Illustrate with an example. **4**

b) Define lambda-cut set. Discuss the properties of lambda - cut sets. **4**

c) The fuzzy sets **8**

$$\underset{\sim}{A}_1 = \{(-1,1), (0,0.4), (1,0.2), (2,0.5)\}\ \&$$

$$\underset{\sim}{A}_2 = \{(-1,0.5), (0, 0.08), (1,1), (2,0.4)\}$$

and the mapping function is

$f(x_1, x_2) = x_1^2 + x_2^2$, then find $\underset{\sim}{B}$ using the Extension principle.

7. a) You are asked to select an implementation technology for a numerical processor. Computation throughput is directly related to clock speed. Assume that all implementations will be in the same family (e.g. (MOS). You are considering whether the design should be implemented using medium -scale integration (MSI) with discrete. Parts, field programmable array (FPGA) parts, or multichip modules (MCM). Define the universe of potential clock frequencies as $X = \{1,10, 20, 40, 80, 100\}$ MHz and define MSI, FPGA, and MCM as fuzzy sets of clock frequencies that should be implemented in each of these technologies, where the following table defines their membership values. **12**

Clock Frequency (MHz)	MSI	FPGA	MCM
1	1	0.3	0
10	0.7	1	0
20	0.4	1	0.5
40	0	0.5	0.7
80	0	0.2	1
100	0	0	1

Representing the three sets as
MSI = $\underset{\sim}{M}$, FPGA = $\underset{\sim}{F}$ and MCM = $\underset{\sim}{C}$,
Find the following:

i) $\underset{\sim}{M} \cup \underset{\sim}{F}$ ii) $\underset{\sim}{M} \cap \underset{\sim}{F}$

iii) $\overline{\underset{\sim}{M}}$ iv) $\overline{\underset{\sim}{F}}$

v) $\underset{\sim}{C} \cap \overline{\underset{\sim}{F}}$ vi) $\overline{\underset{\sim}{M} \cap \underset{\sim}{C}}$

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b) Discuss the properties of t-norms fuzzy operations. **4**

OR

8. a) An engineer is asked to develop a glass break detector/discriminator for use with residential alarm systems. The detector should be able to distinguish between the breaking of a pane of a glass (a window) and a drinking glass from analysis it has been determined that the sound of a shattering window pane contains most of its energy at frequencies centered about 4 KHz, whereas the sound of a shattering drinking glass contains most of it's energy at frequencies centered about 8 KHz. The spectra of the two shattering sounds overlap. The membership functions for the window pane and the glass are given as $\mu_{\underset{\sim}{A}}(x)$ and $\mu_{\underset{\sim}{B}}(x)$, respectively illustrate the basic operations of union, intersection, complement and difference for the folowing membership functions. **12**

$x = 0,1, ----, 10; \sigma = 2;$

$\mu_{\underset{\sim}{A}} = 4; \mu_{\underset{\sim}{B}} = 8$

$$\mu_{\underset{\sim}{A}}(x) = \exp\left[\frac{-\left(x-\mu_{\underset{\sim}{A}}\right)^2}{2\sigma^2}\right]$$

$$\mu_{\underset{\sim}{B}}(x) = \exp\left[\frac{-\left(x-\mu_{\underset{\sim}{B}}\right)^2}{2\sigma^2}\right]$$

b) Discuss the various features of the fuzzy membership functions. **4**

9. a) Write a short note on: **8**

1) Lattice fuzzy number
2) Fuzzy equations

b) Define interval number. The interval numbers A = [-3 5] and B = [-2 7] then find the following operations on interval numbers. **8**

i) A (+) B ii) A (-) B
iii) A (·) B iv) A (/) B
v) A ($\vee$) B vi) A ($\wedge$) B

OR

10. a) Define linguistic variable. Elaborate the concept of linguistic variables with an suitable example. **8**

b) Define fuzzy number. The fuzzy numbers **8**

$\underset{\sim}{A} = \{(2,1); (3, 0.5)\}$ and $\underset{\sim}{B} = \{(3,1); (4, 0.5)\}$

then find following operations on fuzzy numbers:

i) $\underset{\sim}{A}(+)\underset{\sim}{B}$ ii) $\underset{\sim}{A}(-)\underset{\sim}{B}$
iii) $\underset{\sim}{A}(\cdot)\underset{\sim}{B}$ iv) $\underset{\sim}{A}(/)\underset{\sim}{B}$
v) $\underset{\sim}{A}(\vee)\underset{\sim}{B}$ vi) $\underset{\sim}{A}(\wedge)\underset{\sim}{B}$

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