

**IV B.Tech II Semester Regular Examinations, Apr/May 2006**  
**FUZZY LOGIC AND APPLICATION**  
**(Electrical & Electronic Engineering)**

Time: 3 hours

Max Marks: 80

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. Let the fuzzy sets A, B and C be the sub sets of the universe  $\{1,2,3, \dots, 199,200\}$ .  
 Let  $A = \{1/0.1, 2/0.3, 3/0.3, 4/0.4, 5/0.5, 6/0.7, 7/0.8, 8/0.9, 9/1, 10/1\}$  and  
 $B = \{1/0.1, 2/0.3, 3/0.5, 4/0.7, 5/0.9, 6/1, 7/0.8, 8/0.5, 9/0.2, 10/0\}$ . Find out the  
 fuzzy sets  $C = A*(A+B)$ ;  $C = A^2$ ;  $C = 1/B$ . [16]
2. Write mathematical crisp equations for max-min composition and max product compositions. [16]
3. Define a specific triangle as shown in Figure 1 with three ordered angles  
 $\{X: A=50^\circ \geq B=50^\circ \geq C=80^\circ, \text{ where } A+B+C= 180^\circ\}$

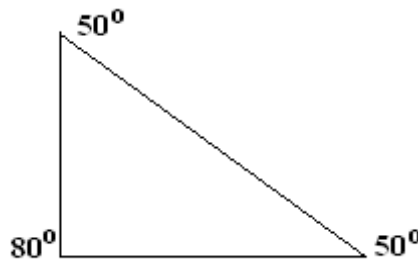


Figure 1:

- Determine fuzzy Triangle sets  $\mu_R(x)$ ,  $\mu_L(x)$ ,  $\mu_{LR}(x)$ ,  $\mu_E(x)$ ,  $\mu_T(x)$  and justify out of these five triangle sets which one have high value. [16]
4. What is Zadeh's Extension Principle? [16]
  5.  $\sqrt{3}$  is not a rational number; i.e., show that it can not be the ratio of two even integers by contradiction? [16]
  6. We have a situation involving fluid pump where the flow through the pump must be controlled in fairly accurate manner. We can assess the flow with two atomic terms "high" and "low" flow

$$\text{"High"} = \left\{ \frac{0}{0} + \frac{0}{50} + \frac{0.3}{100} + \frac{0.6}{150} + \frac{0.7}{200} + \frac{0.8}{250} + \frac{0.9}{300} + \frac{0.95}{350} + \frac{1}{400} \right\}$$

$$\text{"Low"} = \left\{ \frac{1}{0} + \frac{0.9}{50} + \frac{0.8}{100} + \frac{0.5}{150} + \frac{0.2}{200} + \frac{0.1}{250} + \frac{0}{300} + \frac{0}{350} + \frac{0}{400} \right\}$$

Find membership functions for other kinds of fluid flow for the following phrases

- (a) Slightly low and not very low

(b) slightly low and not very high

(c) Not very high or not very low.

[16]

7. An aircraft control system is a totally non linear system when the final approach and Landing of an air craft are considered. It involves maneuvering flight in an appropriate Course to the air port and then along the optimum glide path trajectory to the to the run way. We know that this path is usually provided by an instrument landing system which transmits two radio signals to the air craft as a navigational aid. These orthogonal radio beams are known as the localizer and glide slope under transmitted from the ends of the run way in order to provide the approaching air craft with the correct trajectory for landing. The pilot executing such a landing must monitor cockpit instruments that display the position of the air craft relative the desired flight path and make appropriate corrections to the controls. Presume that four positions are available to the pilot and that four corrections  $P_1$ ,  $P_2$ ,  $P_3$  and  $P_4$  from the actual position  $P$  are required to put the air craft on the correct course. Let the subjective estimation as follows:  $P_1$ ,  $P_2$ ,  $P_3$  and  $P_4$  estimate  $P$  with fuzzy measurement 0.3, 0.5, 0.6 and 0.8 respectively. The pair wise comparisons for the four positions are as follows:

$$\begin{array}{cccc} f_{p1}(p_1)=1 & f_{p2}(p_2)=.5 & f_{p1}(p_3)=0.6 & f_{p1}(p_4)=0.8 \\ f_{p2}(p_1)=0.3 & f_{p2}(p_2)=1 & f_{p2}(p_3)=0.4 & f_{p2}(p_4)=0.3 \\ f_{p3}(p_1)=0.6 & f_{p3}(p_2)=0.4 & f_{p3}(p_3)=1 & f_{p3}(p_4)=0.6 \\ f_{p4}(p_1)=0 & f_{p4}(p_2)=0.3 & f_{p4}(p_3)=0.6 & f_{p4}(p_4)=1 \end{array}$$

Compute the comparison matrix?

[16]

8. A fuzzy tolerance relation.  $R$ . is reflexive and symmetric. Find the equivalence relation  $R$  and then classify it according to  $\lambda$ -cut levels  $=\{0.9, 0.8, 0.5\}$ .

$$R = \begin{Bmatrix} 1 & 0.8 & 0 & 0.2 & 0.1 \\ 0.8 & 1 & 0.9 & 0 & 0.4 \\ 0 & 0.9 & 1 & 0 & 0.3 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.1 & 0.4 & 0.3 & 0.5 & 1 \end{Bmatrix} \quad [16]$$

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1. Develop a responsible membership function for the fuzzy color set “red” based on the frequencies of the color spectrum. [16]
2. Write a short note on fuzzy relations? [16]
3. How to generate membership function by using Neural networks? [16]
4. For the function  $y = x_1^2 + x_2^2 - 3x_1 + 4$ , where the membership functions for fuzzy variables  $X_1$ ,  $X_2$  shown in Figure 1: find and plot the membership function for the fuzzy out put variable,  $y$ , using the vertex method. [16]

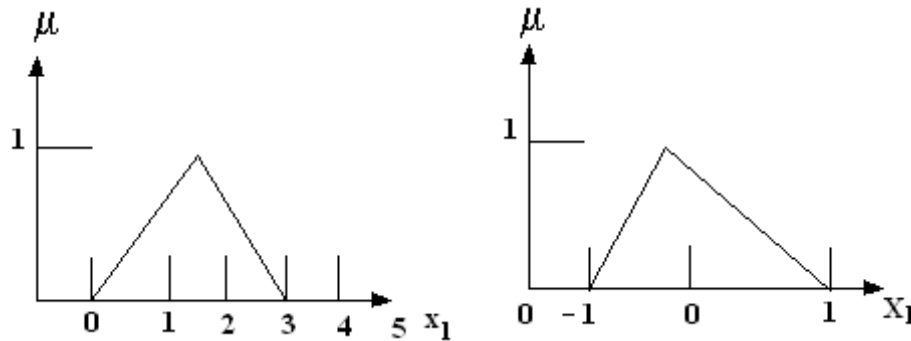


Figure 1:

5. For the proposition R of the form  $P \rightarrow Q$ , the converse of R and the inverse of R are equivalent. Prove that  $(Q \rightarrow P) \leftrightarrow (\bar{P} \rightarrow \bar{Q})$ . [16]
6. Write a short notes on rule - based systems? [16]
7. What is fuzzy ordering? [16]
8. As a first step in automatic segmentation of magnetic resonance imaging (MRI) data regarding the head, it is necessary to determine the orientation of the data set to be segmented. The standard radiological orientations are sagittal, Coronal, and horizontal. One way to classify the orientation of the new data would be to compare a slice of the new data to slices of known orientation. To do the classification we will use a simple metric obtained by overlaying slides images and obtaining an area of intersection. Then normalizing these, based on the largest area of interaction.

This metric will be our “degree of resemblance” for the equivalence relation. From data you have following fuzzy relation.

	<i>S</i>	<i>C</i>	<i>H</i>	<i>N</i>
<i>Sagittal</i>	1	0.6	0.4	0.7
<i>Coronal</i>	0.6	1	0.5	0.7
<i>Horizontal</i>	0.4	0.5	1	0.5
<i>NewSlice</i>	0.7	0.7	0.5	1

- (a) What kind of relation is this?
- (b) Determine the equivalence relation and conduct a classification at -cut levels of 0.4, 0.6 and 0.7. [16]

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1. Develop a responsible membership function for a square based on a geometric properties of a rectangle. For this problem use  $L$  as the length of the longer side and  $l$  as the length of the smaller side. [16]
2. Write a short note on fuzzy relations? [16]
3. What is Fuzzification? Explain clearly with suitable example? [16]
4. For the function  $y = x_1^2 + x_2^2 - 3x_1 + 4$ , where the membership functions for fuzzy variables  $X_1$ ,  $X_2$  shown in Figure 1: find and plot the membership function for the fuzzy out put variable,  $y$ , using A discretized form of the extension principle. [16]

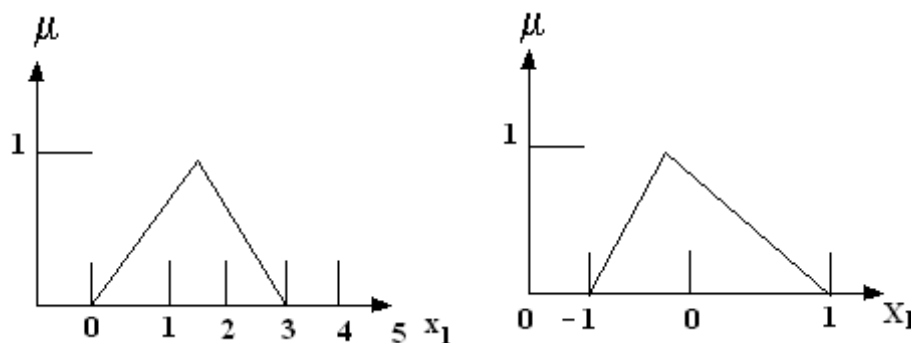


Figure 1:

5. For the inference rule  $[(A \rightarrow B) \wedge (B \rightarrow C)] \rightarrow (A \rightarrow C)$ . Show that the rule is a quasi tautology for fuzzy sets. [16]
6. In the field of hydrology the study of rain fall patterns is most important. The rate of rain fall in units of mm per hour, failing in a particular geographic region could be described linguistically. Suppose we defined membership functions for the linguistic variables “Heavy” and “Light”
 
$$\text{“Heavy”} = \left\{ \frac{0.2}{5} + \frac{0.4}{8} + \frac{0.6}{12} + \frac{0.8}{20} + \frac{1}{30} \right\}$$

$$\text{“Light”} = \left\{ \frac{0}{30} + \frac{0.1}{20} + \frac{0.5}{12} + \frac{0.8}{8} + \frac{1}{5} \right\}$$
 Develop member ship function for
  - (a) very high

(b) fairly heavy  $\left([heavy]^{2/3}\right)$

(c) not very light. [16]

7. Ordering: Consider a comparison of four chemicals with respect to human toxicity. Assume that  $C_1$  is highly toxic,  $C_2$  is very toxic,  $C_3$  is moderately toxic, and  $C_4$  is slightly toxic. Hence, on a pair wise comparison basis,  $C_2$  resembles  $C_1$  with a fuzzy membership value of 0.75,  $C_3$  resemble  $C_1$  with a fuzzy membership of 0.5, and  $C_4$  resembles  $C_1$  with a fuzzy membership of 0.25. the remainder of the pair wise comparison follow:

$$\begin{array}{cccc} f_{c1}(C_1)=1 & f_{c2}(C_2)=0.75 & f_{c1}(C_3)=0.5 & f_{c1}(C_4)=0.25 \\ f_{c2}(C_1)=0.75 & f_{c2}(C_2)=1 & f_{c2}(C_3)=0.5 & f_{c2}(C_4)=0.25 \\ f_{c3}(C_1)=0.5 & f_{c3}(C_2)=0.25 & f_{c3}(C_3)=1 & f_{c3}(C_4)=5 \\ f_{c4}(C_1)=0.25 & f_{c4}(C_2)=0.25 & f_{c4}(C_3)=0.5 & f_{c4}(C_4)=1 \end{array}$$

Develop the comparison matrix and determine the overall ranking of toxicity. [16]

8. A fuzzy tolerance relation.  $R$  is reflexive and symmetric. Find the equivalence relation  $R$  and then classify it according to  $\lambda$ -cut levels  $=\{0.9, 0.8, 0.5\}$ .

$$R = \left\{ \begin{array}{ccccc} 1 & 0.8 & 0 & 0.2 & 0.1 \\ 0.8 & 1 & 0.9 & 0 & 0.4 \\ 0 & 0.9 & 1 & 0 & 0.3 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.1 & 0.4 & 0.3 & 0.5 & 1 \end{array} \right\} \quad [16]$$

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1. (a) Find some examples of prospective fuzzy variables in daily life.  
(b) Explain why we need fuzzy set theory. [16]
2. Let R be the relation among the three sets X= {English, French}, Y= {doller, pound, franc, mark} and Z= {US, France, Canada, Britain, Germany}, Find the fuzzy relation R(X, Y, Z) and express in three dimensional membership array.[16]
3. Write a note on futures of the fuzzy membership function? [16]
4. Two fuzzy sets  $\tilde{A}$   $\tilde{B}$  both defined on X are as follows

$\mu(x_i)$	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	$x_6$
$\tilde{A}$	0.1	0.6	0.8	0.9	0.7	0.1
$\tilde{B}$	0.9	0.7	0.5	0.2	0.1	0

Express the following lambda cut sets using Zadeh's notation

- (a)  $\left(\tilde{A}\right)_{0.7}$
- (b)  $\left(\tilde{B}\right)_{0.4}$
- (c)  $\left(\tilde{A} \cup \tilde{B}\right)_{0.7}$
- (d)  $\left(\tilde{A} \cap \tilde{B}\right)_{0.6}$  [16]
5.  $\sqrt{3}$  is not a rational number; i.e., show that it can not be the ratio of two even integers by contradiction? [16]
6. Amplifier capacity on a normalized universe, say  $[0, 100]$ , can be describe linguistically by fuzzy variables like these:  

$$\text{"Power full"} = \left\{ \frac{0}{1} + \frac{0.4}{10} + \frac{0.8}{50} + \frac{1}{100} \right\}$$

$$\text{"Weak"} = \left\{ \frac{1}{1} + \frac{0.9}{10} + \frac{0.3}{50} + \frac{0}{100} \right\}$$
 find the membership function for the following linguistic phrases used to describe the capacity of various amplifiers;
  - (a) Powerful and not weak
  - (b) Very powerful or very weak

(c) Very, very powerful and not weak. [16]

7. Explain about fuzzy synthetic evaluation? [16]

8. A fuzzy tolerance relation. R. is reflexive and symmetric. Find the equivalence relation R and then classify it according to  $\lambda$ -cut levels  $=\{0.9, 0.8, 0.5\}$ .

$$R = \begin{Bmatrix} 1 & 0.8 & 0 & 0.2 & 0.1 \\ 0.8 & 1 & 0.9 & 0 & 0.4 \\ 0 & 0.9 & 1 & 0 & 0.3 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.1 & 0.4 & 0.3 & 0.5 & 1 \end{Bmatrix} \quad [16]$$

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