

**School of Information Technology  
IIT Kharagpur**

**Course Id: IT60108 Soft Computing Applications**  
**Date: February 20, 2007**  
**Max. Marks: 70**

**Mid Sem Exam**  
**Total Time: 2 Hours**

Instructions: Answer all questions. You may answer the questions in any order. However, all parts of the same question must be answered together. Clearly state any reasonable assumption you make.

1. Consider a fuzzy set A defined by the trapezoidal membership function  $\text{trapezoid}(x; 10, 30, 50, 90)$ .

Determine de-fuzzification results using (a) Centroid of Area (b) Mean of Maximum

**[8+2=10]**

2. (a) Consider a Sugeno Fuzzy Model for inferencing with the following rules:

i. If x is Small and y is Small then  $z = y - x + 1$

ii. If x is Small and y is Large then  $z = -y + 3$

iii. If x is Large and y is Small then  $z = -x + 3$

iv. If x is Large and y is Large then  $z = x + y + 2$

The antecedent fuzzy set memberships are defined as **Small X** =  $\text{sig}(x; -2, 0)$ ; **Large X** =  $\text{sig}(x; 2, 0)$ ; **Small Y** =  $\text{sig}(y; -5, 0)$  and **Large Y** =  $\text{sig}(y; 5, 0)$ . What would be the Sugeno Model output for crisp inputs  $x = 0.2$  and  $y = -0.2$ ? **[10]**

(b) Justify truth or falsity of the following statement **[5]**

A zero-order Sugeno Fuzzy Model is a special case of the Mamdani Fuzzy Inference System

3. Consider the fuzzy set **Young** defined by the membership function  $\text{sig}(\text{age}; -5, 15)$ . Define meaningful membership functions of two fuzzy sets **Too Young** and **More or Less Young** based on the membership function of **Young**. What is the degree of membership value of a student of age 10 in the fuzzy set **More or Less Young but not Too Young**? **[5]**

4. (a) Consider a 2x2 image with pixel gray levels 10, 31, 2, 16. Suggest a membership function (with all parameter values properly defined) to map these gray levels to a fuzzy set **Bright Pixel** such that, if we apply contrast intensification operator (INT) on the membership values, half of the pixels will have their brightness values increased and the other half will have their brightness values decreased. What would be the brightness value of the brightest pixel after contrast intensification? **[5+2=7]**

(b) Define a Contrast Diminisher operator (DIM) such that  $\text{DIM}(\text{INT}(A)) = A$ . What would be the brightness of the least bright pixel if we apply DIM on the original **Bright Pixel** fuzzy set (i.e., the fuzzy set before applying INT)? **[5+3=8]**

5. Consider a fuzzy information retrieval system with the relation R to denote relevance of keywords (x1-x6) to documents (y1-y10) and the relation T to denote a fuzzy thesaurus.

$$R = \begin{bmatrix} & y1 & y2 & y3 & y4 & y5 & y6 & y7 & y8 & y9 & y10 \\ x1 & .2 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ x2 & 1 & 0 & 0 & .3 & 0 & .4 & 0 & 0 & 1 & 0 \\ x3 & 0 & 0 & .8 & 0 & .4 & 0 & 1 & 0 & 0 & 0 \\ x4 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & .9 & .7 & .5 \\ x5 & 1 & 0 & .5 & 0 & 0 & .6 & 0 & 0 & 0 & 0 \\ x6 & 0 & 1 & 0 & 0 & .2 & 0 & 1 & 0 & 0 & .5 \end{bmatrix} \quad T = \begin{bmatrix} & x1 & x2 & x3 & x4 & x5 & x6 \\ x1 & 1 & .2 & 1 & 1 & .5 & 1 \\ x2 & .2 & 1 & .4 & .7 & .9 & 0 \\ x3 & 1 & .4 & 1 & .9 & .3 & 1 \\ x4 & 1 & .7 & .9 & 1 & 0 & 0 \\ x5 & .5 & .9 & .3 & 0 & 1 & .2 \\ x6 & 1 & 0 & 1 & 0 & .2 & 1 \end{bmatrix}$$

Let a fuzzy query Q consists of the keywords x1, x2 and x3 with membership values in fuzzy set **important** as 1, 0.4 and 1, respectively.

- Determine the  $\alpha$ -cut of the fuzzy set “**Documents relevant to the Query Q**” for  $\alpha = 0.8$ ?
- Let us assume that the documents y1, y2, ..., y10 were used 1, 2, ..., 10 days ago, respectively.

Consider a fuzzy set **Recently used** be defined using the membership function trapezoid(day; 0, 1, 5, 8). Let us define a Tsukamoto Fuzzy Model with the following rules (for **not** in the rule antecedents, apply suitable complementation):

- If document is relevant to the query and document is recently used then ranking is high
- If document is not relevant to the query and document is recently used then ranking is medium
- If document is relevant to the query and document is not recently used then ranking is medium
- If document is not relevant to the query and document is not recently used then ranking is low

The consequent fuzzy sets **ranking high** and **ranking low** are respectively defined by sig(ranking; 5, 5) and sig(ranking; -5, 5). Fuzzy set **ranking medium** is defined by a fuzzy singleton set M where  $\mu_M(\text{ranking}) = 1.0$  for ranking = 0.5 and  $\mu_M(\text{ranking}) = 0$  elsewhere. What would be the crisp rankings considering relevance and recency for the documents in the set obtained in Question 5(a) above? **[10+15=25]**