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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: M.Tech-CSE — **Semester – I**
Subject (Course): Fuzzy Logic and Application — **Max. Marks : 100**
Course Code: CSAI7004 — **Duration : 3 Hrs**
No. of page/s:

Section A [4x5=20 Marks]

Q1) Explain the difference between randomness and fuzziness.

Q2) Develop a reasonable membership function for the following fuzzy set based on setting times in minutes of epoxies (a) "Extra fast" (b)"Fast" (c) "Slow"

Q3) A fuzzy tolerance relation, R, i s reflexive and symmetric. Find the equivalence relation Re and then classify it according to λ-cut levels ={0.9, 0.8, 0.5}.

$$\underset{\sim}{R} = \begin{bmatrix} 1 & 0.8 & 0 & 0.2 & 0.1 \\ 0.8 & 1 & 0.9 & 0 & 0.4 \\ 0 & 0.9 & 1 & 0 & 0.3 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.1 & 0.4 & 0.3 & 0.5 & 1 \end{bmatrix}$$

Q4) In a class of 10 students (the universal set), 3 students speaks German to some degree, namely Alice to degree 0.7, Bob to degree 1.0, Cathrine to degree 0.4. What is the size of the subset A of German speaking students in the class?

Section B [4x10=40 Marks]

Q5) The amount of total suspended solids (TSS) in a river vary with the seasons, as do the flows. For example in the summer when the flows are lowest, the TSS can be highest. For the two particular rivers shown here, calculate the union, intersection, and difference of the membership function:

$$A = \left\{\frac{0.15}{winter} + \frac{0.33}{spring} + \frac{0.52}{summer} + \frac{0.25}{fall}\right\}$$

$$B = \left\{\frac{0.1}{winter} + \frac{0.55}{spring} + \frac{0.9}{summer} + \frac{0.2}{fall}\right\}$$

Q6) Elaborate and discuss the three methods of deductive inference for fuzzy system based on linguistic rules.

Q7) Consider the following two discrete fuzzy sets, which are defined on universe X ={−5 , 5 }:

$$\underset{\sim}{A} = \text{``zero''} = \left\{ \frac{0}{-2} + \frac{0.5}{-1} + \frac{1.0}{0} + \frac{0.5}{1} + \frac{0}{2} \right\}$$

$$\underset{\sim}{B} = \text{``positive medium''} = \left\{ \frac{0}{0} + \frac{0.5}{1} + \frac{1.0}{2} + \frac{0.5}{3} + \frac{0}{4} \right\}$$

a) Construct the relation for the rule IF A∼ ,THENB∼ (i.e., IF x is ‘‘zero’’ THEN y is ‘‘positive medium’’) using the Mamdani implication, μR (x, y) = min[μA (x), μB (y)] and μR (x, y) = μA (x) · μB (y)
b) If we introduce a new antecedent,

$$\underset{\sim}{A}' = \text{``positive small''} = \left\{ \frac{0}{-1} + \frac{0.5}{0} + \frac{1.0}{1} + \frac{0.5}{2} + \frac{0}{3} \right\}$$

find the new consequent B∼, using max – min composition, i.e., B∼ = A∼∘R∼, for both relations from part (a).

Q8) Mention the use of fuzzification and defuzzification steps in Fuzzy logic system.

Section C **[2x20=40 Marks]**

Q9) Suppose we are evaluating a new invention to determine its commercial potential. We will use two metrics to make our decisions regarding the innovation of the idea. Our metrics are the ‘‘uniqueness’’ of the invention, denoted by a universe of novelty scales, X ={1 , 2 , 3 , 4 }, and the ‘‘market size’’ of the invention’s commercial market, denoted on a universe of scaled market sizes, Y ={1 , 2 , 3 , 4 , 5 , 6 }. In both universes the lowest numbers are the ‘‘highest uniqueness’’ and the ‘‘largest market,’’ respectively. A new invention in your group, say a compressible liquid of very useful temperature and viscosity conditions, has just received scores of ‘‘medium uniqueness,’’ denoted by fuzzy set A∼ , and ‘‘medium market size,’’ denoted fuzzy set B∼.
We assign the invention the following fuzzy sets to represent its ratings:

$$\underset{\sim}{A} = \text{medium uniqueness} = \left\{ \frac{0.6}{2} + \frac{1}{3} + \frac{0.2}{4} \right\}$$

$$\underset{\sim}{B} = \text{medium market size} = \left\{ \frac{0.4}{2} + \frac{1}{3} + \frac{0.8}{4} + \frac{0.3}{5} \right\}$$

$$\underset{\sim}{C} = \text{diffuse market size} = \left\{ \frac{0.3}{1} + \frac{0.5}{2} + \frac{0.6}{3} + \frac{0.6}{4} + \frac{0.5}{5} + \frac{0.3}{6} \right\}$$

Determine the implication of such a result, i.e.,

a) IF A∼ , THEN B∼.
b) IF x is A∼ , THEN y is B∼, ELSE y is C∼

Q10) Design a motor speed controller for air conditioner. Let temperature (X) be input and motor speed (Y) be output. Elaborate and discuss all the steps for used in this design (eg. the linguistic variables, fuzzy set and fuzzy rules).

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Section A **[4x5=20 Marks]**

Q1) find at least five examples of prospective fuzzy variables in daily life.

Q2) Defuzzification is the process of conversion of a fuzzy quantity into a precise quantity. Justify the given statement and discuss the method for the defuzzification.

Q3) Describe the key difference between a Mamdani controller and a TakagiSugeno-Kang Controller

Q4) In a class of 10 students (the universal set), 3 students speaks German to some degree, namely Alice to degree 0.7, Bob to degree 1.0, Cathrine to degree 0.4. What is the size of the subset A of German speaking students in the class?

Section B **[4x10=40 Marks]**

Q5) Two fuzzy sets A~ and B~, both defined on X, are as follows:

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

Express the following λ-cut sets using Zadeh's notation:

(a) (A~)0.6
(b) (B~)0.4
(c) (A~ ∪ B~)0.7
(d) (A~ ∩ B~)0.6
(e) (A~ ∪ A~)0.7
(f) (B~ ∩ B~)0.5
(g) (A~ ∩ B~)0.7
(h) (A~ ∪ B~)0.7

Q6) Mention the types of machine learning techniques. Discuss the difference between k-mean and Fuzzy c-mean approach with the help of any real time example.

Q7) Consider two Fuzzy set $\tilde{A}$ and $\tilde{B}$are the types of concrete. Four concrete masonry unit (CMUs) for each type of concrete are stressed until they fail. The lowest stress at failure if a CMU is denoted as 1, and the highest stress at failure is denoted as 4, so the CMU are ranked ordered by failure stress that is , X={1,2,3,4}. Since the failure is fuzzy, the membership value for a specific CMU represents the judgment that the CMU really failed. The following fuzzy set represent the failure estimates for the two different concrete types:

$$\tilde{A} = \left\{\frac{0.15}{1} + \frac{0.25}{2} + \frac{0.6}{3} + \frac{0.9}{4}\right\}$$

$$\tilde{B} = \left\{\frac{0.2}{1} + \frac{0.3}{2} + \frac{0.5}{3} + \frac{0.8}{4}\right\}$$

Calculate the union, intersection and the difference for the two concrete types.

Q8) Design a motor speed controller for air conditioner. Let temperature (X) be input and motor speed (Y) be output. Elaborate and discuss all the steps for used in this design (eg. the linguistic variables, fuzzy set and fuzzy rules).

Section C **[2x20=40 Marks]**

Q9) Three variables of interest in power transistors are the amount of current that can be switched, the voltage that can be switched, and the cost. The following membership functions for power transistors were developed from a hypothetical components catalog:

$$\text{Average current (in amps)} = \underset{\sim}{I} = \left\{\frac{0.4}{0.8} + \frac{0.7}{0.9} + \frac{1}{1} + \frac{0.8}{1.1} + \frac{0.6}{1.2}\right\}$$

$$\text{Average voltage (in volts)} = \underset{\sim}{V} = \left\{\frac{0.2}{30} + \frac{0.8}{45} + \frac{1}{60} + \frac{0.9}{75} + \frac{0.7}{90}\right\}$$

these two fuzzy sets are related to the ‘‘power’’ of the transistor. Power in electronics is defined by an algebraic operation, P = V × I

(a) Find the fuzzy Cartesian product P = V × I.

Now let us define a fuzzy set for the cost C, in dollars, of a transistor, e.g.,

$$\underset{\sim}{C} = \left\{\frac{0.4}{0.5} + \frac{1}{0.6} + \frac{0.5}{0.7}\right\}$$

(b) Using a fuzzy Cartesian p roduct, find T = I × C. What would this relation, T, represent physically?

(c) Using max – min composition, find E= P◦T. What would this relation, E, represent physically?

(d) Using max – product composition, find E = P◦T.

Q10) A problem in construction management is to allocate four different job sites to two different construction teams such that the time wasted in shuttling between the sites is minimized. Let the job sites be designated as xi and combined to give a universe, X ={x 1 , x 2 , x 3 , x 4 }. If the head office, where the construction teams start every day, has coordinates {0 , 0 }, the following vectors give the locations of the four job sites:

x 1 ={4 , 5 }, x 2 ={3 , 4 }, x 3 ={8 , 10 }, x 4 ={9 , 12 }

Conduct following calculation to determine the optimum partition

a) Hard c-means
b) fuzzy c- means, U∗. (Use m’ = 2 .0and εL ≤ 0 .01.)Start with the following initial 2-partition: $\underset{\sim}{U}^{(0)} = \begin{Bmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{Bmatrix}$