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16EE654

Sixth Semester B.E. Makeup Examination, May/June 2018-19

FUZZY LOGIC

Time: 3 Hours

Max. Marks: 100

Instructions: 1. *Answer all five questions.*
2. *Unit IV and Unit V are compulsory.*
3. *Choose one full question from remaining units.*

UNIT - I

			L	CO	PO	M
1	a.	Explain the various operations in fuzzy set using graphical representation	(2)	(1)	(1)	(04)
	b.	Explain with example cylindrical extension and projection.	(2)	(1)	(1)	(08)
	c.	For the given two fuzzy sets with universes {1, 2, 3, 4, 5, 6} $A=\left\{\frac{0.1}{2}+\frac{0.8}{3}+\frac{0.9}{4}+\frac{0.6}{5}\right\}$; $B=\left\{\frac{0.3}{2}+\frac{0.7}{3}+\frac{0.2}{4}+\frac{1}{5}+\frac{0}{6}\right\}$; Find, $A\cup B$, $A\cap B$, $\bar{A}$, $\bar{B}$, $\bar{A}\cap\bar{B}$, $\bar{A}\cup\bar{B}$, A/B, B/A.	(2)	(1)	(1)	(08)

OR

			L	CO	PO	M
2	a.	Discuss axioms of T- norms and S-norms giving suitable examples.	(2)	(1)	(1,2)	(04)
	b.	Suppose we have a distillation process where the objective is to separate components of mixture in the input stream. The relation between input variable, temperature and output variable, distillate fraction, is not precise but the human operator of this process has developed an intuitive understanding of this relation. The universe for each of these variables is, X= universe of temperature in degree Fahrenheit Y= Universe of distillate fraction in percentage X= {160, 165, 170, 175, 180, 185, 190, 195} Y= {77, 80, 83, 86, 89, 92, 95, 98} Here A & B are the fuzzy sets defined on the universe X & Y respectively. A= Hot Temperature= $\left\{\frac{0}{175}+\frac{0.7}{180}+\frac{1}{185}+\frac{0.4}{190}\right\}$ B= Good Separation of mixture = $\left\{\frac{0}{89}+\frac{0.5}{92}+\frac{0.8}{95}+\frac{1}{98}\right\}$ Find, $A\cup B$, $A\cap B$, $\bar{A}$, $\bar{B}$, $\bar{A}\cap\bar{B}$, $\bar{A}\cup\bar{B}$, A/B, B/A.	(2)	(1)	(1,2)	(08)
	c.	Let $A=\left\{\frac{1}{2}+\frac{0.8}{3}+\frac{0.7}{4}+\frac{0.6}{5}\right\}$ and $B=\left\{\frac{0.8}{2}+\frac{0.9}{3}+\frac{0.1}{4}+\frac{0.2}{5}\right\}$; Calculate $A\cap B$ using Zadeh's implications, Yoger family implications & Franks family implication.	(3)	(1)	(1,2)	(08)

UNIT – II

			L	CO	PO	M
3	a.	With an example, explain if ____then ____ & if____ then ____ else____ statements used for the inference.	(2)	(3)	(1)	(08)

b. A new optical microscope camera uses a lookup table to relate voltage readings (which are related to illuminance) to exposure time. To aid in the creation of this lookup table, we need to determine how much time the camera should expose the pictures at a certain light level. Define a fuzzy set "around 3 volts" on a universe of voltage readings in volts

$$V_{1.5}=\left\{\frac{0.1}{2.98}+\frac{0.3}{2.99}+\frac{0.7}{3}+\frac{0.4}{3.01}+\frac{0.2}{3.02}\right\} \text{ (volts)}$$

and a fuzzy set "around 1/10 second" on a universe of exposure time in seconds

$$T_{1.5}=\left\{\frac{0.1}{0.05}+\frac{0.3}{0.06}+\frac{0.3}{0.07}+\frac{0.4}{0.08}+\frac{0.5}{0.09}+\frac{0.2}{0.1}\right\} \text{ (Seconds)}$$

(a) Find $R = V \times T$

Now define a third universe of "stops." In photography, stops are related to making the picture some degree lighter or darker than the "average" exposed picture. Therefore, let Universe of Stops = {−2, −1.5, −1, 0, .5, 1, 1.5, 2} (stops). We will define a fuzzy set on this universe as.

Z= a little bit lighter $=\left\{\frac{0.1}{0}+\frac{0.7}{0.5}+\frac{0.3}{1}\right\}$

(b) Find $S = T \times Z$

(c) Find $M = R \circ S$ by max–min composition.

(d) Find $M = R \circ S$ by max–product composition.

(e) Comment on the differences between the results of parts (c) and (d).

(5) (3) (1,2) (12)

OR

4 a. Explain with example linguistic variables and linguistic hedges.

(2) (3) (1) (08)

b. Suppose we are evaluating a new invention to determine its commercial potential. We will use two metrics to make our decision regarding the innovation of the idea. Our metrics are "uniqueness" of the invention, denoted by a universe of novelty scale, X = {1, 2, 3, 4}, and the "market size" of the invention's commercial market, denoted on a universe of scaled market size 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 by fuzzy set B. we wish to determine the implication of such a result, that is, "IF MEDIUM UNIQUNESS THEN MEDIUM MARKET SIZE". We assign the invention the following fuzzy sets to represent its ratings.

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

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

If a new antecedent A' ,"almost high uniqueness" is introduced, what market size B' would be associated with it.

$$A' = \text{ medium uniqueness} = \left\{\frac{0.5}{1}+\frac{1}{2}+\frac{0.3}{3}+\frac{0}{4}\right\}$$

Also comment on the results obtained.

(5) (3) (1,2) (12)

UNIT - III

L CO PO M

5 a. Explain the design parameters of rule base. Explain P, PI & PID like FKBC with an example.

(2) (4) (2) (10)

Note: L (Level),CO (Course Outcome), PO (Programme Outcome), M (Marks)

b. Uniaxial compressive strength is easily performed on cylindrical or prismatic ice samples and can vary with strain rate, temperature, porosity, grain orientation, and grain size ratio. While strain rate and temperature can be controlled easily, the other variables cannot. This lack of control yields an uncertainty in the uniaxial test results. A test was conducted on each type of sample at a constant strain rate of 10^{-4} s^{-1}, and a temperature of $-5^{\circ}C$. Upon inspection of the results the exact yield point could not be determined; however, there was enough information to form fuzzy sets for the failure of the cylindrical and prismatic samples A and B, respectively, as shown in Fig. 5(b). Once the union of A and B has been identified (the universe of compressive strengths, megapascals, $N/m^2 \times 10^6$) we can obtain a defuzzified value for the yield strength of this ice under a compressive axial load. Calculate the defuzzified value, z^* using COG, Height, MOM, LOM & FOM methods.

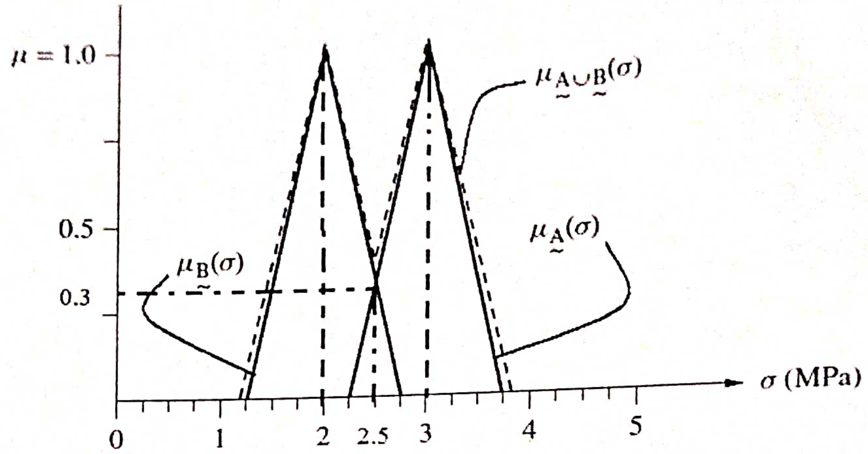

Fig.5(b)

(5) (4) (1,2,4) (10)

OR

6 a. With the help of neat block diagram, explain FKBC.

(2) (4) (1) (10)

b. A railroad company intends to lay a new rail line in a particular part of a county. The whole area through which the new line is passing must be purchased for right-of-way considerations. It is surveyed in three stretches, and the data are collected for analysis. The surveyed data for the road are given by the sets,B1, B2, and B3, where the sets are defined on the universe of right-of-way widths, in meters. For the railroad to purchase the land, it must have an assessment of the amount of land to be bought. The three surveys on right-of-way width are ambiguous, however, because some of the land along the proposed railway route is already in public domain and will not need to be purchased. Additionally, the original surveys are so old (circa 1860) that some ambiguity exists on boundaries and public right-of-way for old utility lines and old roads. The three fuzzy sets, B1, B2, and B3, shown in Figs. 6 a, b & c respectively, represent the uncertainty in each survey as to the membership of right-of-way width, in meters, in privately owned land. We now want to aggregate (union of a, b & c) these three survey results to find the single most nearly representative right-of-way width (z) to allow the railroad to make its initial estimate of the right-of-way purchasing cost.

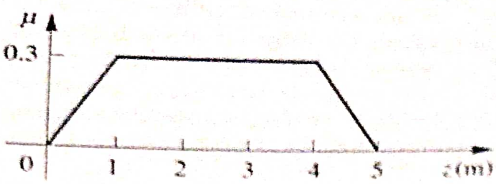

Fig a.: Fuzzy set B1: public right-of-way width (z) for survey 1.

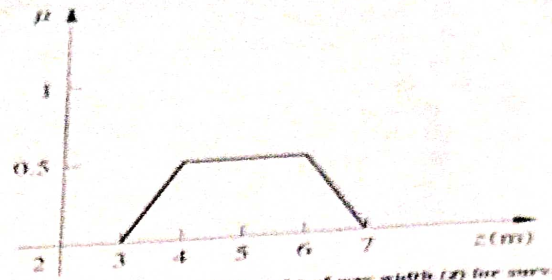

Fig b: Fuzzy set B2: public right-of-way width (z) for survey 2.

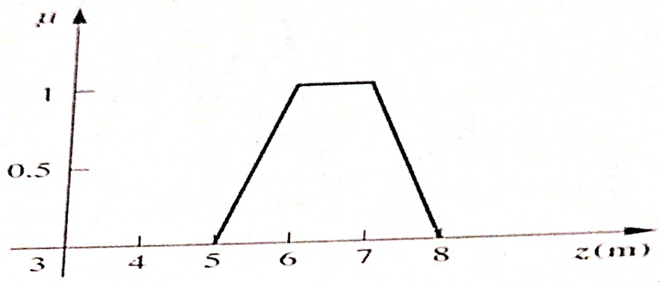

Fig c.:Fuzzy set B3: public right-of-way width (z) for survey 3.

Fig.6 a, b and c

Calculate the defuzzified value, z* using COG and Height methodfor the union of fig. a, b & c.

(5)	(4)	(1,2,4)	(10)
L	CO	PO	M

UNIT – IV (Compulsory).

7 a. Design an FKBC for aircraft landing control. Illustrate the design and analyse the results with the following steps.

- i. Formation of linguistic variables, term sets.
- ii. Normalisation (if needed)
- iii. Fuzzification process
- iv. Type of inference engine
- v. Formation of rules
- vi. Rule firing
- vii. Defuzzification using COG method
- **viii.** Denormalisation (if needed)

(6)	(4)	(,3,4,5)	(20)
L	CO	PO	M

UNIT –V (Compulsory).

8 a. Write a brief note on Adaptation mechanism.

(2) (5) (1) (10)

b. Explain in brief, gradient descent method.

(2) (5) (1) (10)

Note: L (Level),CO (Course Outcome), PO (Programme Outcome), M (Marks)

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16EE551

Fifth Semester B.E. Makeup Examination, January 2020

FUZZY LOGIC

Time: 3 Hours **Max. Marks: 100**

Instructions: *1. Answer any one full question from each unit.*
2. Make suitable assumptions, if any.

			L	CO	PO	M
		UNIT - I				
1	a.	Explain the following terms: Normal, subnormal, convex, non-convex fuzzy set & Lambda cut for a fuzzy set.	(2)	(1)	(1)	(04)
	b.	We want to compare two sensors based upon their detection levels and gain settings. For a universe of discourse of gain settings, X = {0, 20, 40, 60, 80, 100}, the sensor detection levels for the monitoring of a standard item provides typical membership functions to represent the detection levels for each of the sensors; these are given below in standard discrete form: $S_1=\left\{\frac{0}{0}+\frac{0.5}{20}+\frac{0.65}{40}+\frac{0.85}{60}+\frac{1.0}{80}+\frac{1.0}{100}\right\}$; $S_2=\left\{\frac{0}{0}+\frac{0.45}{20}+\frac{0.6}{40}+\frac{0.8}{60}+\frac{0.95}{80}+\frac{1.0}{100}\right\}$; Find the following membership functions using standard fuzzy operations: Find, $S_1\cup S_2$, $S_1\cap S_2$, $\bar{S_1}$, $\bar{S_2}$, $\bar{S_1}\cap\bar{S_2}$, $\bar{S_1}\cup\bar{S_2}$, S_1/S_2, S_2/S_1	(4)	(1)	(1,2)	(08)
	c.	Given a set of measurements of the magnetic field near the surface of a person's head, we want to locate the electrical activity in the person's brain that would give rise to the measured magnetic field. This is called the inverse problem, and it has no unique solution. One approach is to model the electrical activity as dipoles and attempt to find one to four dipoles that would produce a magnetic field closely resembling the measured field. For this problem it is required to model the procedure a neuroscientist would use in attempting to fit a measured magnetic field using either one or two dipoles. The scientist uses a reduced chi-square statistic to determine how good the fit is. If R = 1.0, the fit is exact. If R ≥ 3, the fit is bad. Also a two-dipole model must have a lower R than a one-dipole model to give the same amount of confidence in the model. The range of R will be taken as R = {1.0, 1.5, 2.0, 2.5, 3.0} and we define the following fuzzy sets for D1 = the one-dipole model and D2 = the two-dipole model: $D1=\left\{\frac{1}{1}+\frac{0.75}{1.5}+\frac{0.3}{2}+\frac{0.15}{2.5}+\frac{0}{3}\right\}$; $D2=\left\{\frac{1}{1}+\frac{0.6}{1.5}+\frac{0.2}{2}+\frac{0.1}{2.5}+\frac{0}{3}\right\}$ A∩B Find, T-norms, using Yagers and Franks family implications.	(4)	(1)	(1,2,4)	(08)
		OR				
2	a.	Suppose we have a universe of integers, Y = {1, 2, 3, 4, 5}. We define the following linguistic terms as a mapping onto Y: $small=\left\{\frac{1}{1}+\frac{0.8}{2}+\frac{0.6}{3}+\frac{0.4}{4}+\frac{0.2}{5}\right\}$; $large=\left\{\frac{0.2}{1}+\frac{0.4}{2}+\frac{0.6}{3}+\frac{0.8}{4}+\frac{1}{5}\right\}$; Find, "not very small and not very very large"	(3)	(1)	(1,2)	(04)
	b.	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 shatteringwindow pane contains most of its energy at frequencies centered about 4 kHz whereas the sound of a shattering drinking glass contains most of its 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 $\mu_A(x)$ and $\mu_B(x)$, respectively. Illustrate the basic operations of union, intersection and complement for the following membership functions: Here, the universe of discourse is X = {0, 1,2,3,4,5,6}. Also σ = 2, μ_A= 4 & μ_B= 8.				

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

Form the fuzzy sets using the above expressions and perform the operations.

(4) (1) (1,2,4) (08)

c. Explain the various shapes of membership function along with the appropriate diagram and equations.

(2) (1) (1) (08)

L CO PO M

UNIT – II

3 a. With an example, explain if ___ then ___ & if___ then ____ else_____ statements used for the inference.

(2) (2) (1) (10)

b. 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 wish to determine the implication of such a result, i.e., "IF Medium Uniqueness, THEN Medium market size ELSE diffused market size". We assign the invention the following fuzzy sets to represent its ratings:

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

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

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

Suppose that the fuzzy relation just developed, i.e.,R, describes the invention's commercial potential. It is required to know what market size would be associated with a uniqueness score of "almost high uniqueness."i.e., with a new antecedent, A', find the consequent, B', using max-product composition. Also comment on the results.

$$\underset{\sim}{A'} = \text{almost high uniqueness} = \left\{\frac{0.5}{1} + \frac{1}{2} + \frac{0.3}{3} + \frac{0}{4}\right\}$$

(4) (2) (1,2,3) (10)

OR

4 a. Explain with example, composition rule of inference and generalized modus of ponens. Also find the power using Cartesian product P= V×I for the given fuzzy sets.

Let the three variables in the power transmission are voltage, current and cost.

$$\text{Average current (In Amps)= I}= \left\{\frac{0.4}{0.8} + \frac{0.7}{0.9} + \frac{1}{1} + \frac{0.8}{1.1} + \frac{0.6}{1.2}\right\}$$

$$\text{Average Voltage (In Volts) =V}= \left\{\frac{0.2}{30} + \frac{0.8}{45} + \frac{1}{60} + \frac{0.9}{75} + \frac{0.7}{90}\right\}$$

(2) (2) (1,2,4) (10)

b. For research on the human visual system, it is sometimes necessary to characterize the strength of response to a visual stimulus based on a magnetic field measurement or on an electrical potential measurement. When using magnetic field measurements, a typical experiment will require nearly 100 off/on presentations of the stimulus at one location to obtain useful data. If the researcher is attempting to map the visual cortex of the brain, several stimulus locations must be used in the experiments. When working with a new subject, a researcher will make preliminary measurements to determine if the type of stimulus being used evokes a good response in the subject. The magnetic measurements are in units of femtotesla (10-15 tesla). Therefore, the inputs and outputs are both measured in terms of magnetic units. The defined parameters are, inputs on the universe X = [0, 50, 100, 150, 200] femtotesla, and outputs on the universe Y = [0, 50, 100, 150, 200] femtotesla. It is required to define two fuzzy sets, two different stimuli, on universe X:

$$W = \text{"weak stimulus"} = \left\{\frac{1}{0} + \frac{0.9}{50} + \frac{0.3}{100} + \frac{0}{150} + \frac{0}{200}\right\} \subset X$$

$$M = \text{"medium stimulus"} = \left\{\frac{0}{0} + \frac{0.4}{50} + \frac{1}{100} + \frac{0.4}{150} + \frac{0}{200}\right\} \subset X$$

and one fuzzy set on the output universe Y,

$$S = \text{"severe response"} = \left\{\frac{0}{0} + \frac{0}{50} + \frac{0.5}{100} + \frac{0.9}{150} + \frac{1}{200}\right\} \subset Y$$

Construct the proposition: IF "weak stimulus" THEN not "severe response," using classical implication.
If a new antecedent for the input, M="medium stimulus", is introduced, then find the response on the Y universe to relate approximately the new stimulus M, i.e., to find T= M∘R using max min composition & max product composition. Also comment on both the results.

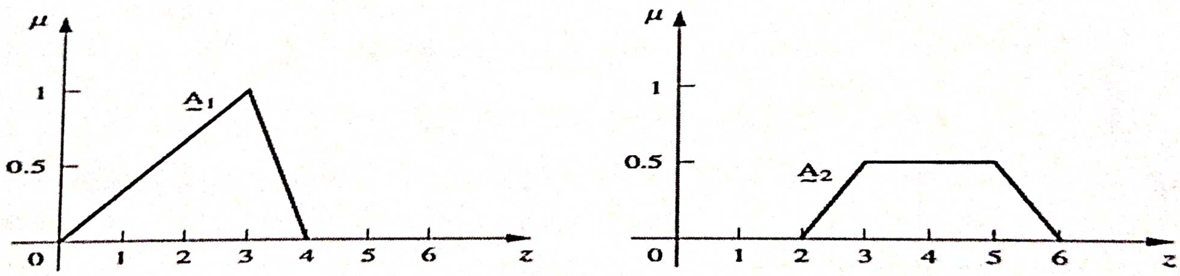
(5)	(2)	(1,2,4)	(10)
L	CO	PO	M

UNIT - III

5 a. Explain different types of defuzzification methods in detail.

(2)	(3)	(1)	(08)

b. In metallurgy, materials are made with mixtures of various metals and other elements to achieve certain desirable properties. In a particular preparation of steel, three elements, namely iron, manganese, and carbon, are mixed in two different proportions. The samples obtained from these two different proportions are placed on a normalized scale, as shown in figure below and are represented as fuzzy sets A1 and A2. You are interested in finding some sort of "average" steel proportion. For the logical union of the membership functions shown it is required to find the defuzzified quantity. Calculate the defuzzified value, z* using COG, weighted average, peak, MOM, FOM and LOM methods.



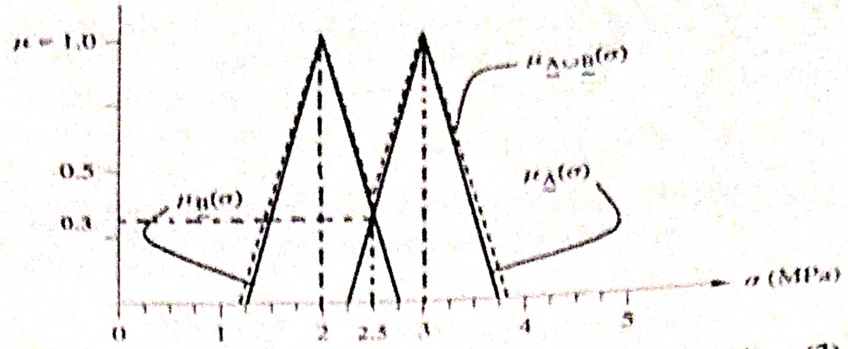
(a) (b)

(4)	(3)	(1,2,4)	(12)

OR

6 a. Uniaxial compressive strength is easily performed on cylindrical or prismatic ice samples and can vary with strain rate, temperature, porosity, grain orientation, and grain size ratio. While strain rate and temperature can be controlled easily, the other variables cannot. This lack of control yields an uncertainty in the uniaxial test results. A test was conducted on each type of sample at a constant strain rate of $10^{-4}\ s^{-1}$, and a temperature of −5∘C. Upon inspection of the results the exact yield point could not be determined; however, there was enough information to form fuzzy sets for the failure of the cylindrical and prismatic samples A and B, respectively, as shown in Fig. Once the union of A and B has been identified (the universe of compressive strengths, Megapascals ($N/m^2 \times 10^6$)) we can obtain a defuzzified value for the yield strength of this ice under a compressive axial load. Calculate the defuzzified value, z* using COG, Height, MOM, LOM & FOM methods.

Note: L (Level),CO (Course Outcome), PO (Programme Outcome), M (Marks)



(4) (3) (1,2,4) (12)

b. With neat diagram explain Fuzzy knowledge based controller.

(2) (3) (1) (08)

L	CO	PO	M

UNIT - IV

7 a. Design an FKBC for a fully automatic washing machine. Illustrate the design and analyse the results with the following steps.

i. Formation of linguistic variables, term sets.
ii. Normalisation (if needed)
iii. Fuzzification process
iv. Type of inference engine
v. Formation of rules
vi. Rule firing
vii. Defuzzification using COG method
viii. Denormalisation (if needed)

(6) (4) (1,2,4) (20)

OR

8 a. Design an FKBC for an aircraft landing control. Illustrate the design and analyse the results with the following steps.

i. Formation of linguistic variables, term sets.
ii. Normalisation (if needed)
iii. Fuzzification process
iv. Type of inference engine
v. Formation of rules
vi. Rule firing
vii. Defuzzification using COG method
viii. Denormalisation (if needed)

(6) (4) (1,2,4) (20)

L	CO	PO	M

UNIT -V

9 a. Explain membership functions tuning using gradient descent method.

(2) (5) (1) (10)

b. Explain with block diagram, self-organizing fuzzy controller.

(2) (5) (1) (10)

OR

10 a. Explain with block diagram, online gradient descent method.

(2) (5) (1) (10)

b. Explain adaptive mechanism used to improve the performance of the controller by varying the controller parameters.

(2) (5) (1) (10)

Note: L (Level),CO (Course Outcome), PO (Programme Outcome), M (Marks)

USN ☐☐☐☐☐☐☐☐☐☐ **16EE551**

Fifth Semester B.E. Semester End Examination, Dec./Jan. 2019-20

FUZZY LOGIC

Time: 3 Hours Max. Marks: 100

Instructions: 1. Answer any one full question from each unit.
2. Make suitable assumptions, if any.

UNIT - I

Q			L	CO	PO	M
1	a.	Explain with an example, projection and cylindrical extension.	(2)	(1)	(1)	(06)
	b.	Methane bio-filters can be used to oxidize methane using biological activities. It has become necessary to compare performance of two test columns, A and B. The methane outflow level at the surface, in non-dimensional units of X = {50, 100, 150, 200}, was detected and is tabulated below against the respective methane inflow into each test column. The following fuzzy sets represent the test columns: $A=\left\{\frac{0.15}{50}+\frac{0.25}{100}+\frac{0.5}{150}+\frac{0.7}{200}\right\}$; $B=\left\{\frac{0.2}{50}+\frac{0.3}{100}+\frac{0.6}{150}+\frac{0.65}{200}\right\}$ Find, $A \cup B$, $A \cap B$, $\bar{A}$, $\bar{B}$, $\bar{A} \cap \bar{B}$, $\bar{A} \cup \bar{B}$, A/B	(2)	(1)	(1)	(07)
	c.	Discuss axioms of T- norms and S-norms giving suitable examples.	(2)	(1)	(1,2,3)	(07)

OR

Q			L	CO	PO	M
2	a.	Compare Classical set and fuzzy set using Venn diagrams.	(2)	(1)	(1,2,3)	(04)
	b.	Suppose you are a soils engineer. You wish to track the movement of soil particles under strain in an experimental apparatus that allows viewing of the soil motion. You are building pattern recognition software to allow a computer to monitor and detect the motions. However, there are two difficulties in "teaching" your software to view the motion: (1) the tracked particle can be occluded by another particle; (2) your segmentation algorithm can be inadequate. One way to handle the occlusion is to assume that the area of the occluded particle is smaller than the area of the unoccluded particle. Therefore, when the area is changing you know that the particle is occluded. However, the segmentation algorithm also makes the area of the particle shrink if the edge detection scheme in the algorithm cannot do a good job because of poor illumination in the experimental apparatus. In other words, the area of the particle becomes small as a result of either occlusion or bad segmentation. You define two fuzzy sets on a universe of non-dimensional particle areas, X = [0, 1, 2, 3, 4]: A is a fuzzy set whose elements belong to the occlusion, and B is a fuzzy set whose elements belong to inadequate segmentation. Let $A=\left\{\frac{0.1}{0}+\frac{0.4}{1}+\frac{1}{2}+\frac{0.3}{3}+\frac{0.2}{4}\right\}$; $B=\left\{\frac{0.2}{0}+\frac{0.5}{1}+\frac{1}{2}+\frac{0.4}{3}+\frac{0.1}{4}\right\}$; Find, $A \cup B$, $A \cap B$, $\bar{A}$, $\bar{B}$, $\bar{A} \cap \bar{B}$, $\bar{A} \cup \bar{B}$, A/B, B/A	(4)	(1)	(1)	(08)
	c.	Explain the various shapes of membership function along with the appropriate diagram and equations.	(2)	(1)	(1)	(08)

UNIT – II

Q			L	CO	PO	M
3	a.	Explain with example linguistic variables and linguistic hedges.	(2)	(2)	(1,2,3)	(10)
	b.	In the city of Calgary, Alberta, there are a significant number of neighborhood ponds that store				

overland flow from rainstorms and release the water downstream at a controlled rate to reduce or eliminate flooding in downstream areas. To illustrate a relation using the Cartesian product let us compare the level in the neighborhood pond system based on a 1-in-100 year storm volume capacity with the closest three rain gauge stations that measure total rainfall.
Let A= Pond system relative depths based on 1-in-100 year capacity (assume the capacities of four ponds are p1, p2, p3, and p4, and all combine to form one outfall to the trunk sewer).
Let B= Total rainfall for event based on 1-in-100 year values from three different rain gage stations, g1, g2, and g3. Suppose we have the following specific fuzzy sets:

$$A=\left\{\frac{0.2}{p1}+\frac{0.6}{p2}+\frac{0.5}{p3}+\frac{0.9}{p4}\right\};\ B=\left\{\frac{0.4}{g1}+\frac{0.7}{g2}+\frac{0.8}{g3}\right\};$$

Let C= Pond system relative depths in the neighbouring areas (p5, p6, p7, p8 & p9)

$$C=\left\{\frac{0.6}{p5}+\frac{0.7}{p6}+\frac{0.5}{p7}+\frac{0.8}{p8}+\frac{0.9}{p9}\right\};$$

Find the cartesian product P=A×B & Q=B×C, and comment on the result.
Also find the fuzzy relation E= C∘D for the two ponding systems using,
(a) max–min composition;
(b) max–product composition.
And comment on both the results. (4) (2) (1,2) (

OR

4 a. Explain with example If___then____ and If____then___else____. (2) (2) (1,2,3) (10)

b. You are asked to develop a controller to regulate the temperature of a room. Knowledge of the system allows you to construct a simple rule of thumb: when the temperature is HOT then cool room down by turning the fan at the fast speed, or, expressed in rule form, "IF temperature is HOT, THEN fan should run FAST". Fuzzy sets for hot temperature on universe X in °F,and fast fan speed on universe Y in rpm is given as,

$$H=hot=\left\{\frac{0}{60}+\frac{0.1}{70}+\frac{0.7}{80}+\frac{0.9}{90}+\frac{1}{100}\right\};\ F=fast=\left\{\frac{0}{0}+\frac{0.2}{1000}+\frac{0.5}{2000}+\frac{0.9}{3000}+\frac{1}{4000}\right\};$$

(a) From these two fuzzy sets construct a relation R for the rule "IF temperature is HOT, THEN fan should turn FAST".

(b) Suppose a new rule uses a slightly different temperature, say ''moderately hot,'' and is expressed by the fuzzy membership function for ''moderately hot,''

$$H`=moderately\ hot=\left\{\frac{0}{60}+\frac{0.1}{70}+\frac{0.7}{80}+\frac{0.9}{90}+\frac{1}{100}\right\};$$

(c) Using max–min composition and max-product composition, find the resulting fuzzy fan speed B'=H'∘R and comment on both the results.

(4) (2) (1,2,) (10)

UNIT - III

		L	CO	PO	M

5 a. Explain in detail, choice of rule base & data base. (2) (3) (1) (08)

b. Many products, such as tar, petroleum jelly, and petroleum, are extracted from crude oil. In a newly drilled oil well, three sets of oil samples are taken and tested for their viscosity. The results are given in the form of the three fuzzy sets B1, B2, and B3, all defined on a universe of normalized viscosity, as shown in Fig given below. It is required to find the most nearly representative viscosity value for the union of all three oil samples, and hence find Z* using COG, Weighted average, MOM, LOM, FOM and height methods for the union of three fuzzy viscosity sets.

Note: L (Level),CO (Course Outcome), PO (Programme Outcome), M (Marks)

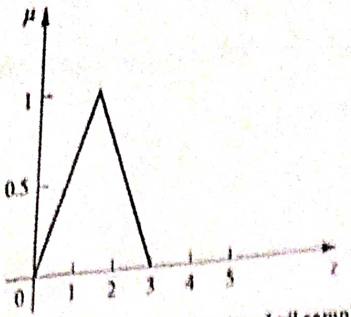


Fig 1: Membership in viscosity of oil sample B1

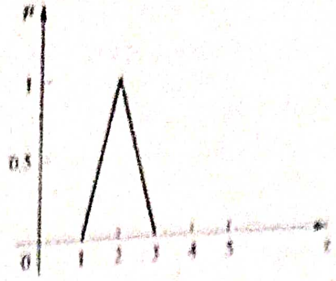


Fig 2: Membership in viscosity of oil sample ,B2

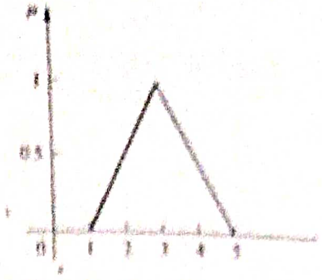


Fig 3: Membership in viscosity of sample ,B3

(4) (3) (1,2,4) (12)

OR

6 a. With neat diagram explain Fuzzy knowledge based controller.

(2) (3) (1) (08)

b. A railroad company intends to lay a new rail line in a particular part of a county. The whole area through which the new line is passing must be purchased for right-of-way considerations. It is surveyed in three stretches, and the data are collected for analysis. The surveyed data for the road are given by the sets,B1, B2, and B3, where the sets are defined on the universe of right-of-way widths, in meters. For the railroad to purchase the land, it must have an assessment of the amount of land to be bought. The three surveys on right-of-way width are ambiguous, however, because some of the land along the proposed railway route is alreadypublic domain and will not need to be purchased. Additionally, the original surveys are so old (circa 1860) that some ambiguity exists on boundaries and public right-of-way for old utility lines and old roads. The three fuzzy sets,B1, B2 and B3, shown in Figs. 1, 2, and 3, respectively, represent the uncertainty in each survey as to the membership of right-of-way width, in meters, in privately owned land. It is required to aggregate these three survey results to find the single most nearly representative right-of-way width (z) to allow the railroad to make its initial estimate of the right-of-way purchasing cost. Find Z* using COG, Weighted average, MOM, LOM, FOM and height methods for the union of three fuzzy sets.

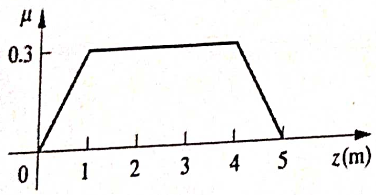


Fig1: Fuzzy setB1: public right-of-way width (z) for survey 1.

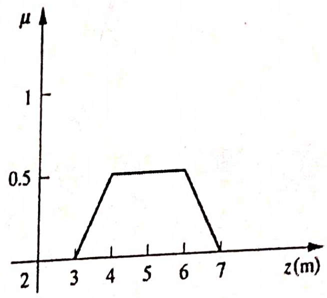


Fig2: Fuzzy set B2 public right-of-way width (z) for survey 2.

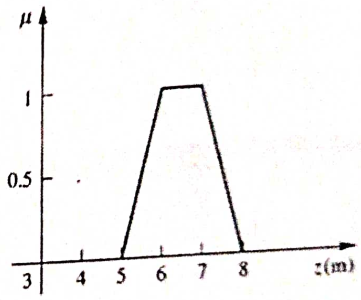


Fig3: Fuzzy set B3: public right-of-way width (z) for survey 3.

(4) (3) (1,2,4) (12)

L CO PO M

UNIT - IV

7 a. Design an FKBC for a temperature control for a fully automatic air conditioner. Illustrate the design and analyse the results with the following steps.

i. Formation of linguistic variables, term sets.
ii. Normalisation (if needed)
iii. Fuzzification process
iv. Type of inference engine
v. Formation of rules
vi. Rule firing
vii. Defuzzification using COG method
viii. Denormalisation (if needed)

(6) (4) (1,2,4) (20)

Note: L (Level),CO (Course Outcome), PO (Programme Outcome), M (Marks)

OR

8 a. Design an FKBC for a speed control of DC motor. Illustrate the design and analyse the results with the following steps.

i. Formation of linguistic variables, term sets.
ii. Normalisation (if needed)
iii. Fuzzification process
iv. Type of inference engine
v. Formation of rules
vi. Rule firing
vii. Defuzzification using COG method
viii. Denormalisation (if needed)

(6) (4) (1,2,4) (20)

UNIT -V

		L	CO	PO	M
9 a.	Explain membership functions tuning using gradient descent method.	(2)	(5)	(1,2)	(10)
b.	Explain with block diagram, model based controller.	(2)	(5)	(1,2)	(10)

OR

10 a.	Explain membership function tuning using performance criteria.	(2)	(5)	(1,2)	(10)
b.	Explain adaptive mechanism used to improve the performance of the controller by varying the controller parameters.	(2)	(5)	(1,2)	(10)

USN : ____________________ Course Code :18EEPE551/16EE551

Fifth Semester B.E Semester End Examination, JANUARY MARCH 2021

FUZZY LOGIC

Time: 3 hrs Max. Marks :100

Instructions :1.Answer FIVE full Questions selecting at least ONE Question from Each Unit.

L CO PO M

MODULE 1

1a. Explain with an example Cylindrical extension and Projection [2] [1] [1, 2] [8]

1b

Let $A=\left\{\frac{0}{2}+\frac{0.8}{3}+\frac{0.7}{4}+\frac{0.6}{5}\right\}$

and

$B=\left\{\frac{0.8}{2}+\frac{0.9}{3}+\frac{1}{4}+\frac{0.2}{5}\right\}$;

Calculate A∩B using Zadehis implications, Yoger family implications & Franks family implication. [3] [1] [1, 2, 4] [12]

OR

2a. In neighborhoods there may be several storm-water ponds draining to a single downstream trunk sewer. In this neighborhood the city monitors all ponds for height of water caused by storm events. For two storms (labeled A and B) identified as being significant based on rainfall data collected at the airport, determine the corresponding performance of the neighborhood storm-water ponds.

Suppose the neighborhood has five ponds, i.e., X = [1, 2, 3, 4, 5], and suppose that significant pond storage membership is 1.0 for any pond that is 70% or more to full depth. For storm A the pond performance set is

$$A=\left\{\frac{0.6}{1}+\frac{0.3}{2}+\frac{0.9}{3}+\frac{1}{4}+\frac{1}{5}\right\}$$

For storm B the pond performance set is,

$$B=\left\{\frac{0.8}{1}+\frac{0.4}{2}+\frac{0.9}{3}+\frac{0.7}{4}+\frac{1}{5}\right\}$$

Find the union, intersection, differenceand compliment for the given two fuzzy sets. [3] [1] [1, 2] [8]

2b. Compare classical set theory and Fuzzy theory [2] [1] [1, 2] [4]

2c. Explain with neat diagram and equations, any four shapes of membership function. [2] [1] [1, 2] [8]

MODULE 2

3a. Suppose we are evaluating a new invention to determine its commercial potential. We will use two metrics to make our decision regarding the innovation of the idea. Our metrics are "uniqueness" of the invention, denoted by a universe of novelty scale, X={1, 2, 3, 4}, and the "market size" of the invention's commercial market, denoted on a universe of scaled market size 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 by fuzzy set B. we wish to determine the implication of such a result, that is, "IF MEDIUM

UNIQUNESS THEN MEDIUM MARKET SIZE". We assign the invention the following fuzzy sets to represent its ratings.

A=medium uniqueness =

$\left\{ \frac{0.6}{2} + \frac{1}{3} + \frac{0.2}{4} \right\}$

B=medium market size

$\left\{ \frac{0.4}{2} + \frac{1}{3} + \frac{0.8}{4} + \frac{0.3}{5} \right\}$

If a new antecedent A' ,"almost high uniqueness" is introduced, what market size B' would be associated with it. i.e. find B'=A'o R using max product composition.

A'=medium uniqueness =

$\left\{ \frac{0.5}{1} + \frac{1}{2} + \frac{0.8}{3} + \frac{0.3}{4} \right\}$ [3] [2] [1, 2, 4] [12]

3b. Explain with an example, Linguistic variable and Linguistic hedges. [2] [2] [1, 2] [8]

OR

4a. Levees are relatively small, earth made dams that are used to protect urban areas from flooding. The leaves will only work if the water level in them remains below the levee is height. If the water level goes higher than the levee height damn will occur downstream of the levee in an amount proportional to the excess water height. Let X be the Universe of excess water height to levee height ratio (percentage),X= {0.5, 0.75, 1, 1.75} and let Y be the Universe of damage indices (million dollar). Y= {0, 0.5, 1, 7}.Suppose we have for the sets for a given water height ratio (WH) and a given damage in millions (D), as follows;

1.Moderate water height ratio (percentage)=

$\left\{ \frac{1}{0.5} + \frac{1}{0.75} + \frac{0.6}{1} + \frac{0.1}{1.75} \right\}$,

1.Relatively large damage (million dollars)=

$\left\{ \frac{0.2}{0} + \frac{0.3}{0.5} + \frac{0.8}{1} + \frac{1}{7} \right\}$

1.Use a classical implication to find the relation "if moderate water height ratio then a relatively large damage"

2.Suppose we are given a new water height ratio (WH') =

$\left\{ \frac{0}{0.5} + \frac{1}{0.75} + \frac{0.7}{1} + \frac{0.4}{1.75} \right\}$

Use Max-min composition and Max-Product composition to find out the damage associated with the with this new water height ratio

4b. Explain the following terms, [3] [2] [1, 2, 4] [14]

1.Composition rule of inference,

2.Generalized modus of ponens

MODULE 3

[2] [2] [1, 2] [6]

5a. A railroad company intends to lay a new rail line in a particular part of a county. The whole area through which the new line is passing must be purchased for right-of-way considerations. It is surveyed in three stretches, and the data are collected for analysis. The surveyed data for the road are given by the sets, B1, B2, and B3, where the sets are defined on the universe of right-of-way widths, in meters. For the railroad to purchase the land, it must have an assessment of the amount of land to be bought. The three surveys on right-of-way width are ambiguous, however, because some of the land along the proposed railway route is already public domain and will not need to be purchased. Additionally, the original surveys are so old (circa 1860) that some ambiguity exists on boundaries and public right-of-way for old utility lines and old roads. The three fuzzy sets, B1, B2, and B3, shown in Figs. a, b & c respectively, represent the uncertainty in each survey as to the membership of right-of-way width, in meters, in privately owned land. We now want to aggregate (union of a, b & c) these three survey results to find the single most nearly representative right-of-way width (z) to allow the railroad to make its initial estimate of the right-of-way purchasing cost. Calculate the defuzzified value, z□ using all the applicable method for the union of fig. a, b & c,

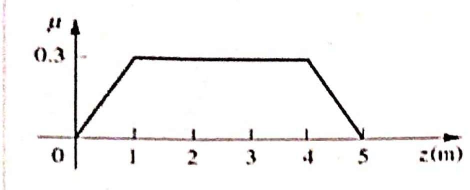


Fig a: Fuzzy set B1: public right of way width (z) for survey 1.

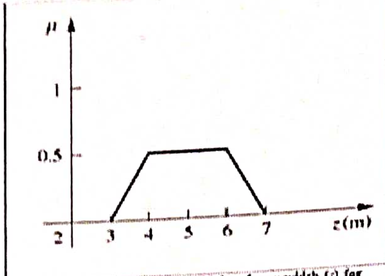


Fig b: Fuzzy set B2: public right of way width (z) for survey 2.

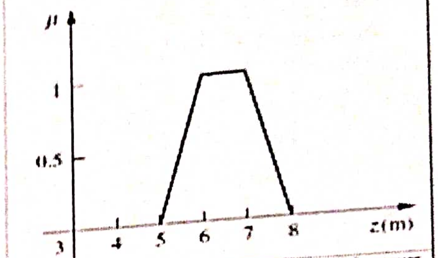


Fig c: Fuzzy set B3: public right of way width (z) for survey 3.

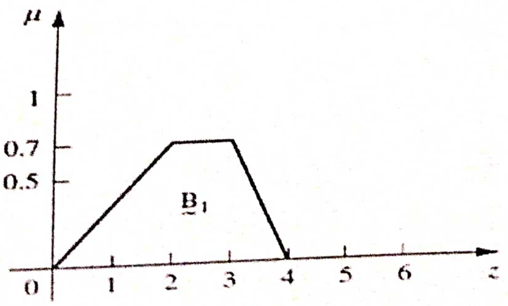
[4] [3] [1, 2, 4, 11] [12]

5b. With neat block diagram explain the structure of fuzzy knowledge based controller (FKBC)

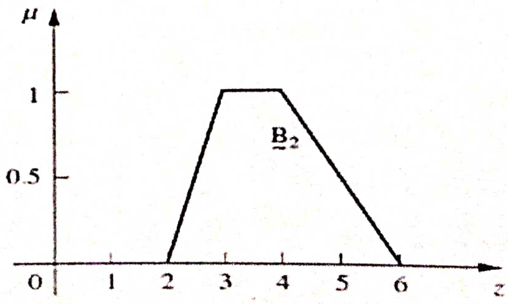
[2] [3] [1, 2] [8]

OR

6a. Two companies bid for a contract. A committee has to review the estimates of those companies and give reports to its chairperson. The reviewed reports are evaluated on a non-dimensional scale and assigned a weighted score that is represented by a fuzzy membership function, as illustrated by the two fuzzy sets, B1 and B2, in Fig a & b respectively. The chairperson is interested in the lowest bid, as well as a metric to measure the combined "best" score. For the logical union of the membership functions shown we want to find the defuzzified quantity. Calculate the defuzzified value, z*using all the applicable methods.



(a)



(b)

[4] [3] [1, 2, 4, 11] [12]

6b. Explain in detail the choice of data base and rule base

[2] [3] [1, 2, 4] [8]

MODULE 4

7. Design an FKBC for an aircraft landing control. Illustrate the design and analyse the results with the following steps.

1.Formation of linguistic variables, term sets.
2.Normalisation (if needed)
3.Fuzzification process
4.Type of inference engine
5.Formation of rules
6.Rule firing
7.Defuzzification using COG method
Denormalisation (if needed)

[6] [4] [1, 2, 3, 5, 7, 11, 12] [20]

OR

8. Design an FKBC for a temperature control of an AC. Illustrate the design and analyse the results with the following steps.

1.Formation of linguistic variables, term sets.
2.Normalisation (if needed)
3.Fuzzification process
4.Type of inference engine
5.Formation of rules
6.Rule firing
7.Defuzzification using COG method
Denormalisation (if needed)

[6] [4] [1, 2, 3, 5, 7, 11, 12] [20]

MODULE 5

9a. With neat block diagramand flow chart, explain membership function tuning using performance criteria.

[2] [5] [1, 2] [10]

9b. Explain in brief, adaptive fuzzy controller.

[2] [5] [1, 2] [10]

OR

10a. With neat block diagram, explain model based controller

[2] [5] [1, 2] [10]

10b. With neat bock diagram and algorithm, explain online gradient descent method.

[2] [5] [1, 2] [10]