Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem 2019-20
Course Code: ECE 310
Course Name: FUZZY LOGIC AND ITS ENGINEERING APPLICATIONS
Program & Sem: B.Tech (ECE) & V DE

Date: 01.10.2019
Time: 2.30PM to 3.30PM
Max Marks: 40
Weightage: 20%

Instructions:

(i) *Bring Your own materials – exchange is not allowed*
(ii) *The Depth of Answer should be according to the marks allotted*

Part A [Memory Recall Questions]

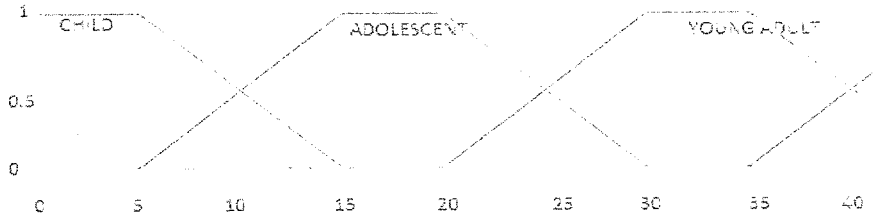
Answer all the Questions. Each Question carries three marks. **(4Qx3M=12M)**

1. Write Formulas for And Or Pairs (6*(1/2)=3M)
   (a) Hamacher
   (b) Einstein
   (c) Drastic
   (d) Algebraic
   (e) MAX MIN
   (f) Which is most commonly used? (C.O.NO.1)[Knowledge]
2. Universes of Discourse are A = {a1,a2,a3,a4}, B={b1,b2.b3), with member sets $P = \{\frac{0.1}{a1} + \frac{0.3}{a2} + \frac{0.5}{a3} + \frac{0.7}{a4}\}$;$Q = \{\frac{0.2}{b1} + \frac{0.8}{b2} + \frac{0.2}{b3}\}$;
   (i) Specify at least 4 properties of Q
   (ii) Find NOT Q
   (iii) Draw P graphically and show its support, core, boundaries
   (C.O.NO.2)[Comprehenison]
3. Which Laws of Classical logic do you feel will not apply for FUZZY logic? Define any Fuzzy Set membership function and prove your statement.
   (C.O.NO.1)[CComprehenison]
4. Write a short note explaining precision versus cost/ utility. What is the name of this curve? Where on this curve is the domain of FL?
   (C.O.NO.1)[Comprehension]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries eight marks. **(2Qx8M=16M)**

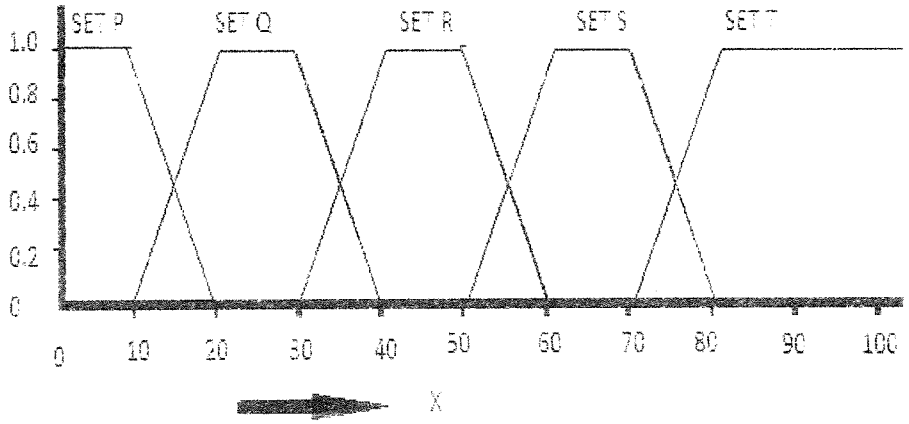
5. For the curves with respect to age in years, the membership functions for various categories are given by the following graphs



Deduce (a) Support for Adolescent (b) Core for Adolescent (c) Child OR adolescent curve (d) Child AND adolescent curve (e) If you were 12 year old, which set do you belong to? Is it normal or subnormal? (f) λ Cut of Adolescent at λ = 0.5

(C.O.NO.2)[Application]

6.



Find the memberships of x in all the given sets for X values given (a) X= 5 (b) 64 (e) 12 (f) 36. Write your answer with STANDARD NOTATIONS in a tabulated form

(C.O.NO.2)[Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries six marks. **(2Qx6M=12M)**

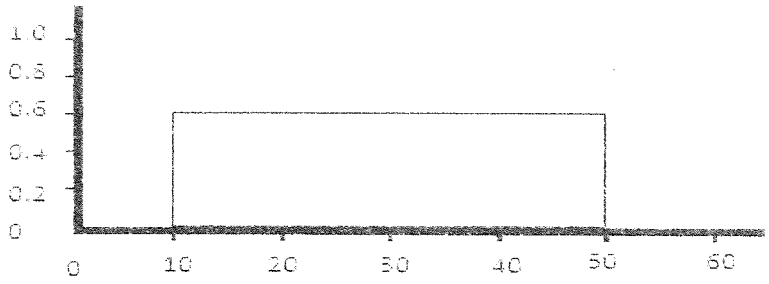
7. Solve the following problems with **BOTH** Max- Min and Algebraic Sum and Product pairs of operators if p=1 q=0.2 r= 0.3 s=0.8 t=0.9 u=1
   (a) q.r and q+r
   (b) s.t and s+t

[3+3=6M]

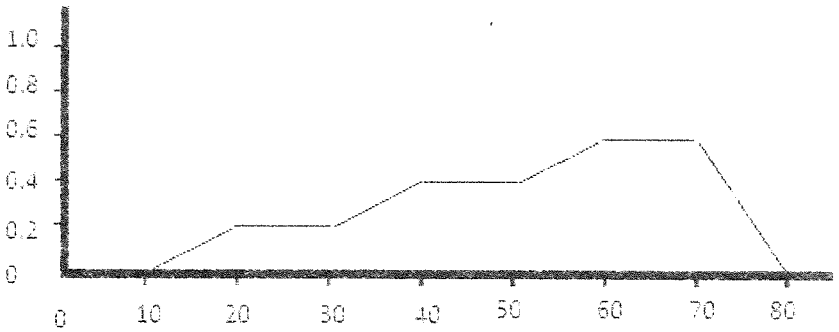
(C.O.NO.2)[Comprehension]

8.

(a) Name and Compare 3 Defuzzification Techniques. Solve following by centroid



(b) The Result of an Operation on a washing cycle results in



Defuzzify With
(i) MOM
(ii) Weighted Average

[1+1+1+3=6M]
(C.O.NO.3)[Application]

SCHOOL OF ENGINEERING

Semester: 5th

Course Code: ECE 310

Course Name: Fuzzy Logic and Its Engineering Applications

Branch & Sem: ECE 5th Sem

Date: 01.10.19

Time: 02.30pm to 03.30pm

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1.	CO1	Module1	3			3
2.	CO2	Module2	1	2		3
3.	CO1	Module1	1	2		3
4.	CO1	Module1		3		3
5.	CO2	Module2	2	2	4	8
6.	CO2	Module2	4		4	8
7.	CO2	Module2	2		4	6
8.	CO3	Module3	2		4	6
	Total Marks		15	9	16	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

For Revision Comments Refer Last page

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

Semester: 5th

Course Code: ECE 310

Course Name: Fuzzy Logic and Its Engineering Applications

Branch & Sem: ECE 5th Sem

Date: 01.10.19

Time: 02.30pm to 03.30pm

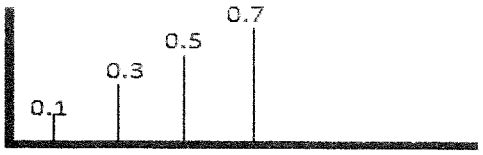
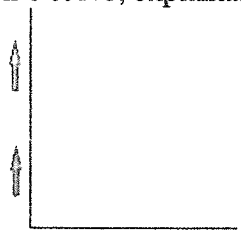
Max Marks: 40

Weightage: 20%

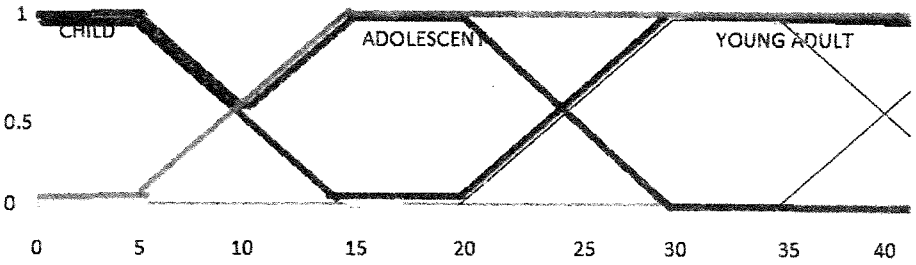
Solutions

Part A (4Q x3 M = 12Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	All specified formula pairs (half mark each) MAX-MIN	0.5*6 = 3M	4 minutes
2	(i) Height =0.8, subnormal, Convex, symmetric, any other properties are allowed (ii) $Q' = \{\frac{0.8}{b1} + \frac{0.2}{b2} + \frac{0.8}{b3}\}$;	1+1+1	4 minutes

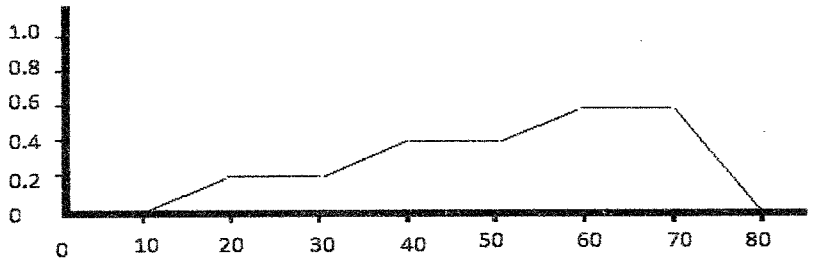
	 (iii)		
3	X+X' is not equal to 1 X.X' is not equal to null Proof by any membership graphs	1.5+1.5	4 minutes
4	Zadeh's curve; explanation  Explanation	Concept one mark, name and explanation 2 marks	4 minutes

Part B (2Q x 8M = 16Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
5	(a) Support for Adolescent 5 to 30 (b) Core for Adolescent 15 to 20 (c) Child OR adolescent curve UNDER RED  (d) Child AND adolescent curve UNDER YELLOW (e) Child AND adolescent – subnormal (f) λ Cut of Adolescent at λ = 0.5 Rectangle of Height = 1 from10 to 25	1+ 1+ 1+ 1+ 2+ 2 = 8	**10 min**
6	(a) X= 5 (b) 64 (e) 12 (f) 36. Write your answer with STANDARD NOTATIONS in a tabulated form	2*4 = 8	10 min

X=	$\mu_P(x)$	$\mu_Q(x)$	$\mu_R(x)$	$\mu_S(x)$	$\mu_T(x)$
5	1	0	0	0	0
64	0	0	0	1	0
12	0.8	0.2	0	0	0
36	0	0.4	0.6	0	0

Part C (2Q x 6M = 12Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time required for each Question</th></tr>
<tr><td>7</td><td>Solve the following problems with BOTH Max- Min and Algebraic Sum and Product pairs of operators p=1 q=0.2 r= 0.3 s=0.8 t=0.9 u=1
(a) MAX – Min q.r = 0.2 and q+r = 0.3
Algebraic Sum and Product q.r = 0.06 and q+r = 0.44
(b) MAX – Min s.t = 0.8 and s+t = 0.9
Algebraic Sum and Product s.t = 0.72 and s+t = 0.98</td><td>6</td><td>9 min</td></tr>
<tr><td>8</td><td>(a) Name and Compare 3 Defuzzification Techniques
<table>
<tr><td>Method</td><td>Speed</td><td>Accuracy</td></tr>
<tr><td>MOM</td><td>Very Fast</td><td>Not Very Accurate</td></tr>
<tr><td>CENTROID</td><td>Very Slow</td><td>Perfectly Accurate</td></tr>
<tr><td>WA</td><td>Almost As Fast As Mom</td><td>Almost As Accurate As Centroid</td></tr>
</table>
(b) The Result of an Operation on a washing cycle results in
 

Defuzzify With (i) MOM = 65 (ii) Weighted Average {25*.2+ 45*.4+65*.6}/{.2+.4+.6}= 55.5</td><td>2+1 +3= 6</td><td>9 min</td></tr>
</table>

Reviewer Comments

1. 58 minute
2. Table boundaries has to be removed
3. Borders to be removed
4. Marks should be evenly distributed
5. Little bit lengthy paper
6. 8 Question Answer details Little bit steps can be included.

Dr. M. Lavy

Roll No.													

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
TEST – 2

Sem & AY: Odd Sem 2019-20
Course Code: ECE 310
Course Name: FUZZY LOGIC AND ITS ENGINEERING APPLICATIONS
Program & Sem: B.Tech (ECE) & V

Date: 19.11.2019
Time: 02.30 PM TO 03.30 PM
Max Marks: 40
Weightage: 20%

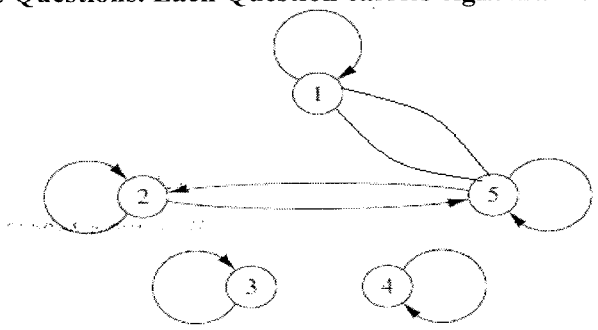
Instructions:
(i) Bring Your own materials – exchange is not allowed
(ii) The Depth of Answer should be according to the marks allotted

Part A [Memory Recall Questions]
Answer all the Questions. Each carries three marks. **(4Qx4M=16M)**

Q1.	Write the Formula for (a) Godelian Implication (b) Goguen Implication (c) Condition on Membership $\mu_A(x)$, and $\mu_B(x)$ if A is a subset of B **(d) Size of Classical** Relation Matrix between sets of 4 and 5 elements respectively	1*4 =4	CO3	L1 Memory
Q2.	What is meant by (a) Reflexivity (b) Symmetry (c) Transitivity (d) Tolerance **properties for any relation**	1*4 =4	CO1	L1 Memory
Q3.	Draw the memberships for Fuzzy Numbers x ~ 1000 with 1% variation on both sides and y ~ 10 with 10% on both sides	2+2 =4	CO3	L2 Comp
Q4.	If p={ 0/x1 +0.3/x2 + 0.8/x3 + 1/x4 + 1/ x5} and q = {0/y1 + .6/y2 + 1/y3 + 1/y4} create relation PxQ and also QxP using Min	2+2 =4	CO1	L2 Comp

Part B [Thought Provoking Questions]
Answer both the Questions. Each Question carries eight marks. **(2Qx7M=14M)**

Q5.



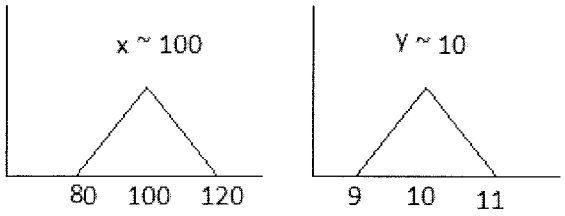
Assuming that the graph represents a classical relation with only 1 and 0 values of each pair, write the relation **matrix** and deduce the values

Matrix 2M — CO1 — L3 App

5 properties 1 mark each

(Either yes followed; or No Not followed) of **all possible properties** of the relation.

Q6. X and Y are given by following functions | 2 2 3 | CO3 | L3 App



Draw the distributions of x+y ; x – y ; x*y

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries six marks. **(2Qx5M=10M)**

Q7. Assume that a race GOCART has six gears, G1, to G6. | 2.5 + 2.5 =5 | CO 3 | L3 App

Similarly it has speeds of ={Speed1, Speed2, Speed3, Speed4, Speed5, Speed6} = {0, 20Kmph, 40 Kmph , 60 Kmph, 80Kmph , 100 Kmph}

High Gears = {0/G1+0/G2+0.3/G3+0.8/G4+1/G5+1/G6}
High Speed = {0/S1 + 0/S2+ 0/ S3 + 0.6/ S4+ 1/ S5 + 1/ S6}

Create (a) Godelian and (b) Goguen Inference matrix **HG →HS** for **"High Gear → High Speed"** and say Which rows are fully valid for both the matrices?

Q8. Five separate regions along the San Andreas fault in California have suffered damage from a recent earthquake. For purposes of assessing payouts from insurance companies to building owners, the five regions must be classified as to their damage levels. Expression of the damage in terms of relations will prove helpful. Surveys are conducted of the buildings in each region. All the buildings in each region are described as being in one of three damage states: no damage, medium damage, and serious damage. Each region has each of these three damage states expressed as a percentage (ratio) of the total number of buildings. Hence, for this problem n = 5 and m = 3. The following table summarizes the findings of the survey team: | 5 | CO 1 | L3 App

Regions	x_1	x_2	x_3	x_4	x_5
x_{i1} – Ratio with no damage	0.3	0.2	0.1	0.7	0.4
x_{i2} – Ratio with medium damage	0.6	0.4	0.6	0.2	0.6
x_{i3} – Ratio with serious damage	0.1	0.4	0.3	0.1	0.0

use the cosine amplitude method to express these data as a 5x5 fuzzy relation between the row variables x1 to x5. Calculate any 5 elements in the upper half matrix. Will the relation show tolerance?

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: 5th

Course Code: ECE 310

Course Name: Fuzzy Logic and Its Engineering Applications

Branch & Sem: ECE 5th Sem

Date: 19/11/19

Time: 2:30 - 3:30

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1.	CO3	M3	4			4
2.	CO1	M1	4			4
3.	CO3	M3		4		4
4.	CO1	M1		4		4
5.	CO1	M1	2		5	7
6.	CO3	M3		2	5	7
7.	CO3	M3			5	5
8.	CO1	M1			5	5
	Total Marks		10	10	20	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

Semester: 5th

Course Code: ECE 310

Course Name: Fuzzy Logic and Its Engineering Applications

Branch & Sem: ECE 5th Sem

Date_____

Time: _____

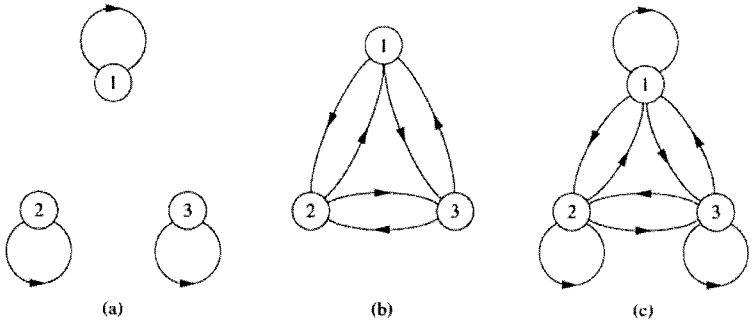
Max Marks: 40

Weightage: 20%

Solutions

Part A (4Q x4 M = 16Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Gödel $I_{GD}(x,y) = \begin{cases} 1 & \text{if } x \leq y \\ y & \text{if } x > y \end{cases}$ Goguen $I_{GG}(x,y) = \begin{cases} 1 & \text{if } x \leq y \\ \frac{y}{x} & \text{if } x > y \end{cases}$ $\mu_A(x) \leq \mu_B(x)$ n*m = 4*5 = 20 elements in 4 rows and 5 columns	1*4 =4	2min

<table>
<tr><td>2</td><td> 

Three-vertex graphs for properties of (a) reflexivity, (b) symmetry, and (c) transitivity
A tolerance relation R (also called a proximity relation) on a universe X is a relation that exhibits only the properties of reflexivity and symmetry.</td><td>1*4 =4</td><td>5min</td></tr>
<tr><td>3</td><td>x ~ 1000 with 1% variation – Triangle from 990 to 1000 to 1010
y ~ 10 with 10% on both sides - Triangle from 9 to 10 to 11</td><td>2+2 =4</td><td>2 min</td></tr>
<tr><td>4</td><td>If p={ 0/x1 +0.3/x2 + 0.8/x3 + 1/x4 + 1/ x5} and q = {0/y1 + .6/y2 + 1/y3 + 1/y4} create relation PxQ and also QxP using Min
PxQ=
<table>
<tr><td></td><td>Y1 (0)</td><td>Y2 (0.6)</td><td>Y3 (1.0)</td><td>Y4 (1.0)</td></tr>
<tr><td>X1 (0)</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>X2 (0.3)</td><td>0</td><td>0.3</td><td>0.3</td><td>0.3</td></tr>
<tr><td>X3 (0.8)</td><td>0</td><td>0.6</td><td>0.8</td><td>0.8</td></tr>
<tr><td>X4 (1.0)</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
<tr><td>X5 (1.0)</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
</table>
QxP = transpose</td><td>2+2 =4</td><td>5min</td></tr>
</table>

Part B (2Q x 7M = 14Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time</th></tr>
<tr><td>5</td><td>
<table>
<tr><td></td><td>X1</td><td>X2</td><td>X3</td><td>X4</td><td>X5</td></tr>
<tr><td>X1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>X2</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>X3</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>X4</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>X5</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
</table>
Reflexive yes; Symm yes; Trans No; Tolerance Yes; Equivalence No</td><td>Mat rix 2M

5 pro per ties 1 mark each</td><td>10min</td></tr>
<tr><td>6</td><td>x+y = triangle 89 to 110 to 131
x – y = triangle 69 to 90 to 111
x*y = curved mbshp 720 to 1000 to 1320</td><td>2
2
3</td><td>10min</td></tr>
</table>

Part C (1Q x 10M = 10Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time</th></tr>
<tr><td>7</td><td>
High Gears = {0/G1+0/G2+0.3/G3+0.8/G4+1/G5+1/G6}
High Speed = {0/0Kmph + 0/20Kmph+ 0/ 40 Kmph + 0.6/ 60 Kmph+ 1/80Kmph + 1/ 100 Kmph
<table>
<tr><td>Godel</td><td>Sp1=0 (0)</td><td>Sp2=20 (0)</td><td>Sp3=40 (0)</td><td>Sp4=60 (0.6)</td><td>Sp5=80 (1.0)</td><td>Sp6= 100 (1.0)</td></tr>
<tr><td>G1 (0)</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G2 (0)</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G3 (0.3)</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G4 (0.8)</td><td>0</td><td>0</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
<tr><td>G5 (1.0)</td><td>0</td><td>0</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
<tr><td>G6 (1.0)</td><td>0</td><td>0</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
</table>
<table>
<tr><td>Goguen</td><td>Sp1=0 (0)</td><td>Sp2=20 (0)</td><td>Sp3=40 (0)</td><td>Sp4=60 (0.6)</td><td>Sp5=80 (1.0)</td><td>Sp6= 100 (1.0)</td></tr>
<tr><td>G1 (0)</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G2 (0)</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G3 (0.3)</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G4 (0.8)</td><td>0</td><td>0</td><td>0</td><td>¾</td><td>1</td><td>1</td></tr>
<tr><td>G5 (1.0)</td><td>0</td><td>0</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
<tr><td>G6 (1.0)</td><td>0</td><td>0</td><td>0</td><td>0.6</td><td>1</td><td>1</td></tr>
</table>
Only last two rows are fully valid
</td><td>2.5
+
2.5
=5</td><td>10</td></tr>
<tr><td>8</td><td>
$$r_{ij} = \frac{\left|\sum_{k=1}^{3} x_{ik}x_{jk}\right|}{\sqrt{\left(\sum_{k=1}^{3} x_{ik}^2\right)\left(\sum_{k=1}^{3} x_{jk}^2\right)}}.$$
For example, for $i = 1$ and $j = 2$, we get
$$r_{12} = \frac{0.3 \times 0.2 + 0.6 \times 0.4 + 0.1 \times 0.4}{[(0.3^2 + 0.6^2 + 0.1^2)(0.2^2 + 0.4^2 + 0.4^2)]^{1/2}} = \frac{0.34}{[0.46 \times 0.36]^{1/2}} = 0.836.$$
Computing the other elements of the relation results in the following tolerance relation:
$$\underset{\sim}{R}_1 = \begin{bmatrix} 1 & & & & \\ 0.836 & 1 & & \text{sym} & \\ 0.914 & 0.934 & 1 & & \\ 0.682 & 0.6 & 0.441 & 1 & \\ 0.982 & 0.74 & 0.818 & 0.774 & 1 \end{bmatrix},$$
</td><td>5</td><td>10</td></tr>
</table>

Roll No												

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20

Course Code: ECE 310

Course Name: FUZZY LOGIC AND ITS ENGINEERING APPLICATIONS

Program & Sem: B.Tech (ECE) & V (DE–II)

Date: 23 December 2019

Time: 9.30 AM to 12.30 PM

Max Marks: 80

Weightage: 40%

Instructions:

(i) Read the all questions carefully and answer accordingly.

(ii) Assume Standard values and pairs

(iii) ***Total marks equal 80 and the total time is 180 minutes – which implies about 2.25 minutes for one mark – answer depth should be according to the marks distribution.***

Part A [Memory Recall Questions]

Answer all the Questions. **(2Qx10M=20M)**

1. Answer the following [1x10=10M]

a. What is a set with membership with height less than one called? What if height is equal to one?

b. When a symmetric Fuzzy number is multiplied with another fuzzy number, the result is symmetric or asymmetric? Linear or nonlinear? Explain why with example

c. Name the three variables that are considered in Zadeh's curve? Explain with curve.

d. What is meant by fuzzification of a value? Show with example

e. What is meant by the terms convexity and symmetry with respect to membership?

f. The set "Perfect teacher" will be normal or subnormal – and why?

g. The set "Dwarf" defined on the height of an average Indian male will be left sided, right sided or symmetrical? What about the set "Giant"? Illustrate with suitable plots.

h. If our universe of discourse is 10 names of only GIRLS in a colony, the relation "sisters" will be symmetric or non-symmetric? Will it be Reflexive? Why?

i. If our universe has 5 boys and 5 girls names, the set "brother" will be symmetric or not? Reflexive? Why?

j. What is the classical cardinality of the power set for a universe with 10 elements? What about fuzzy cardinality? Why?

(C.O.No.1,2,3,4) [Comprehension]

2. Perform the following [2x5=10M]

a. For a universe of temperature ranging from (-5 celsius) to (+45 celsius) define suitable graphs for Cold room, cool room, Warm room and hot room.

b. Name and Write equations/ graphs for any 4 laws which are true for both fuzzy and classical logic systems.

c. What is meant by "Implication"? Name any 2 methods for implication.

d. What is meant by "composing" relations? Give any real life example for it

e. What are the methods to Defuzzification – compare them in short.

(C.O.No.1,2,3,4) [Comprehension]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 5 marks **(8Qx5M=40M)**

3. Given

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad B = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix}$$

Find (i) A U B (ii) A ∩ B (iii) A ° B (iv) B ° A (C.O.No.1) [Comprehension]

4. Given relations R and S; Can we find R ° S or S ° R or both? Find the value of whichever is possible and tell the reason if not possible.

a. Classical relations R and S

$$R = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{cccc} y_1 & y_2 & y_3 & y_4 \end{array} \\ \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array} \quad \text{and} \quad S = \begin{array}{c} \\ y_1 \\ y_2 \\ y_3 \\ y_4 \end{array} \begin{array}{c} \begin{array}{cc} z_1 & z_2 \end{array} \\ \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \end{array}.$$

b. Fuzzy relations R and S

$$\underset{\sim}{R} = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{bmatrix} 0.7 & 0.5 \\ 0.8 & 0.4 \end{bmatrix} \end{array} \quad \text{and} \quad \underset{\sim}{S} = \begin{array}{c} \\ y_1 \\ y_2 \end{array} \begin{array}{c} \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{bmatrix} 0.9 & 0.6 & 0.2 \\ 0.1 & 0.7 & 0.5 \end{bmatrix} \end{array}.$$

(C.O.No.1) [Comprehension]

5. Assume storm magnitudes are recorded on a rain gauge station within a 24 h period. We will represent our assessment of the size of a storm on the universe of rainfall depths, hi , i = 1, 2, 3, where h3 >h2 >h1. The data on depths are based on statistical estimates acquired from numerous rainfall records. The membership function representing the confidence in the rainfall depth of a particular "moderate storm" F~ is given. Suppose D~ is a fuzzy set that represents the rainfall duration, ti (ti < 24 h), where t2 >t1 and the duration can again be derived from statistics. The membership function of a "long duration storm" might be

$$\underset{\sim}{F} = \left\{ \frac{0.4}{h_1} + \frac{1.0}{h_2} + \frac{0.6}{h_3} \right\} \qquad \underset{\sim}{D} = \left\{ \frac{0.1}{t_1} + \frac{1.0}{t_2} \right\}$$

(a) Find the Cartesian product F~ ×D~ = G~ , which provides a relation between rainfall depth and duration.

(b) Then assume you have a fuzzy set of confidence in the measurement of the rainfall depth due to factors such as wind, human error, and instrument type. Such a fuzzy set on the universe

$$\underset{\sim}{E} = \left\{ \frac{0.2}{h_1} + \frac{1.0}{h_2} + \frac{0.3}{h_3} \right\}$$

of depths, say "high confidence in depth h2," could be E. Using a max–min composition find C~ = E~ ∘G~, which represents the best strength of the estimate with respect to the storm duration.

(C.O.No.3) [Application]

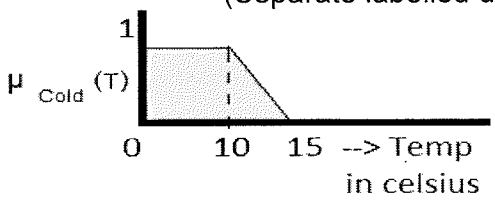
6. A structural designer is considering four different kinds of structural beams (S1 to S4) for a new building. Laboratory experiments on the deflection resistance for these four different kinds of beams have been performed, and the engineer wants to determine their suitability in the new structure. The following data have been observed based on the overall deflection capacity of each beam type: (C.O.No.3) [Application]

		S_1	S_2	S_3	S_4	S_4
No deflection	x_1	0.3	0.2	0.1	0.7	0.4
Some deflection	x_2	0.6	0.4	0.6	0.2	0.6
Excessive deflection	x_3	0.1	0.4	0.3	0.1	0.0

Find the cosine amplitude 5x5 FULL relation matrix using cosine amplitude.

7. The set for "Cold" is given in the graph below. Explain Linguistic Hedges VERY and SOMEWHAT. Find (i) The function equations for membership of cold versus temperature (ii) The Graph for "Very Cold" (iii) The graph for "Somewhat Cold" (iv) The value of membership of Very Cold and Somewhat Cold at T = 12

(Separate labelled diagrams 1+1+1+2M)



(C.O.No.2) [Comprehension]

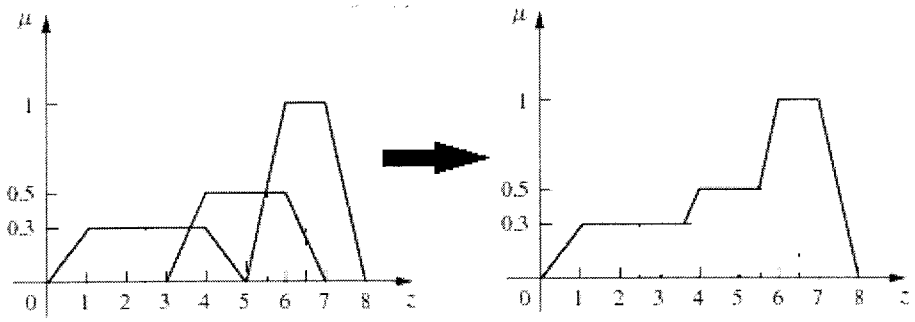
8. **Draw** the memberships for the sets written here; "Warm room" being a trapezoid for parameters (20,25,30,35) and Hot Room with (30,35,50,50) Assume universe is from 0 to 50 degree Celsius. For these sets **State and prove** Demorgan's laws.

(C.O.No.2) [Comprehension]

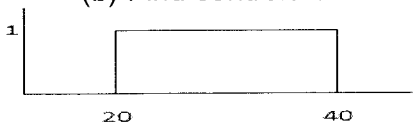
9. Explain Cylindrical Extensions and Fuzzy Graphs. For the Universes U from 0 to 10 and V from 0 to 20. Sets of X □ U and Y□ V. Let us have three rules
(a) If X is Small Then Y is Small
(b) If X is Medium Then Y is Large
(c) If X is Large Then Y is Small
Draw suitable memberships for X= Small, Medium, Large and Y = Small, Large. Draw the fuzzy graph for this rule set.

(C.O.No.2) [Comprehension]

10. (a) Find the cutting points and Defuzzify using MOM and Weighted Average.



(b) Find centroid defuzzification for



(C.O.No.2); [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries 10 marks. (2Qx10M=20M)

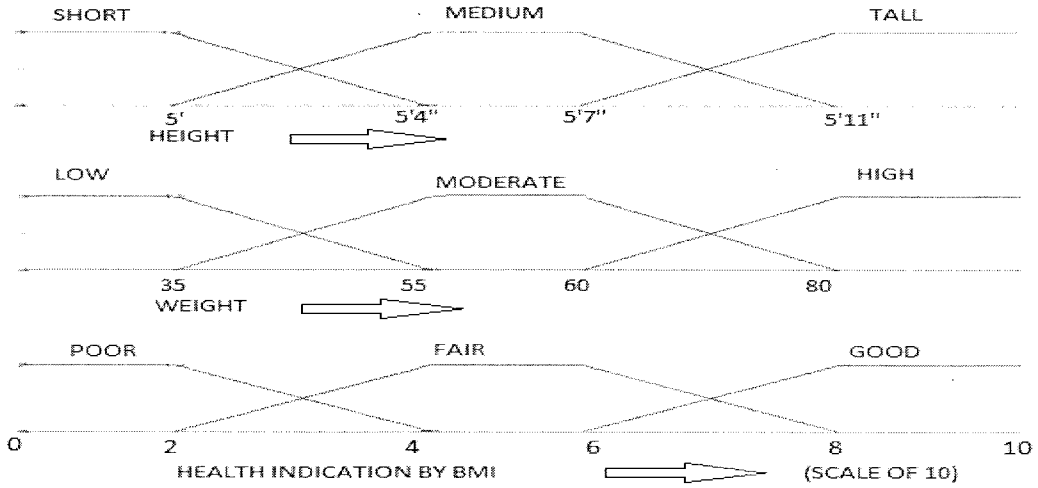
11. Design and explain in **complete detail** the Structure and working of Mamdani control model of Washing machine cycles based on laundry weight and dirtiness. Take different example situations (at least 4 standard cases) and explain.

(C.O.No.4) [Application]

12. (a) Given Relation R. Draw the Sagittal Diagram/ Signal flow graph and specfy whether the system has tolerance and equivalence

$$R_1 = \begin{bmatrix} 1 & 0.3 & 0 & 0.1 & 0.8 \\ 0.3 & 1 & 0.4 & 0 & 0.9 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.1 & 0 & 0 & 1 & 0.5 \\ 0.8 & 0.9 & 0 & 0.5 & 1 \end{bmatrix}$$

(b) Health indicator system is described here



Rules

HEIGHT → WEIGHT ↓	SHORT	MEDIUM	TALL
LOW	Good	FAIR	POOR
MODERATE	FAIR	FAIR	GOOD
HIGH	POOR	POOR	FAIR

Find the antecedent with rule cutting if (a) Height =5'6" and Weight = 60 (b) Height = 6' and Weight = 60 (c) Height = 5'1" and Weight = 75 (1M+1M+3M)

(C.O.No.4) [Application]

SCHOOL OF ENGINEERING

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END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1.	ALL	ALL	5	5	-	10
2.	ALL	ALL	4	6		10
3.	CO1	M1	2	3		5
4.	CO1	M1	-	5		5
5.	CO3	M3		2	3	5
6.	CO3	M3		2	3	5
7.	CO2	M2	2	3		5
8.	CO2	M2	2	3		5
9.	CO2	M2		5		5
10.	CO2	M2	2	3		5
11.	CO4	M4	2	2	6	10
12.	CO1,4	M1,4	2	2	6	10
	Total Marks		21	41	18	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must

be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Format of Answer Scheme

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

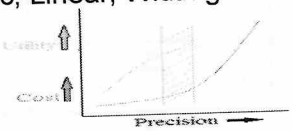
SCHOOL OF ENGINEERING

SOLUTION

Semester: Odd Sem. 2019-20
Course Code: ECE 310
Course Name: Fuzzy Logic and Its Engineering Applications
Program & Sem: B.Tech ECE – 5th Sem

Date: 23.12.2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

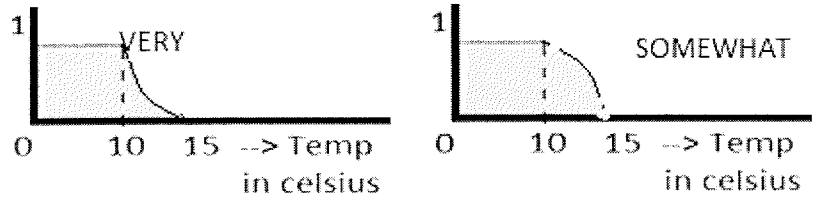
Part A (2Q x 10M = 20Marks)

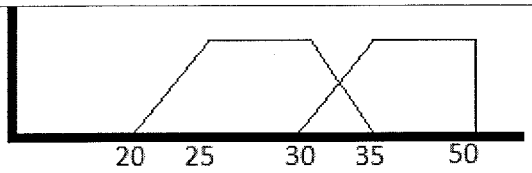
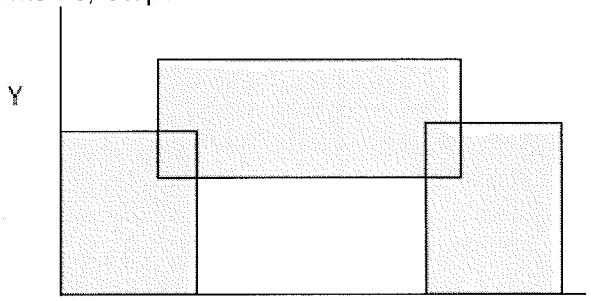
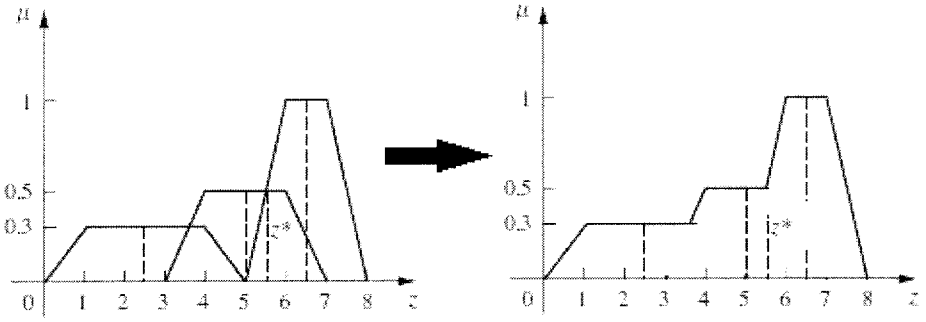
Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	a. H=1 normal; H<1 subnormal b. Symmetric; Linear; Width gets added.  c. Zadeh's d. CE with both matrix and graph e. Non Convex; not symmetric, Normal. By definitions f. Subnormal – Linguistic word PERFECT is fuzzy g. Cold left and Hot right h. Symmetric; Non Reflex. i. Non Symmetric; Non Reflex j. 2^20 = 1 Mega; infinite	10x1=10	10min
2	a. Any suitable graphs showing ranges of Dwarf, Short, Medium, Tall, Giant b. Associative; Distributive; Commutative; Absorption; many more – any two with proofs	2x5 =10	10 min

c, d is missing in solutions

	e. 3 methods mainly – MOM; Centroid; WA; Comparison		

Part B (8Q x 5M = 40 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
3.	Given $A = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ $B = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix}$ Find (i) A U B (ii) A ∩ B (iii) A ° B (iv) B ° A Union = 0 1 0 0 0 1 1 1 1 1 1 1 1 1 0 1 Intersection = 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 0 A ° B= 0 1 1 1 0 1 1 1 0 1 0 0 1 1 0 1 B ° A = 0 1 0 0 1 1 0 1 1 1 0 1 0 1 0 1	5	10 min
4.	Only R to S is possible. S to R is not possible a. 0 1 0 0 0 0 b. 0.7 0.6 0.5 0.8 0.6 0.4	1+1+2=5	10 min
5.	$F = \left\{ \frac{0.4}{h_1} + \frac{1.0}{h_2} + \frac{0.6}{h_3} \right\}$ $D = \left\{ \frac{0.1}{t_1} + \frac{1.0}{t_2} \right\}$ G = FxD = **T1** 0.1 / **T2** 1.0 **H1** 0.4: **0.1** / **0.4** **H2** 1.0: **0.1** / **1.0** H3 0.6: **0.1** / **0.6** $E = \left\{ \frac{0.2}{h_1} + \frac{1.0}{h_2} + \frac{0.3}{h_3} \right\}$ E ° G = { 0.1/t1, 1.0/t2 }	3+2 = 5	10
6.	$R_1 = \begin{bmatrix} 1 & & & & \\ 0.836 & 1 & & & \text{sym} \\ 0.914 & 0.934 & 1 & & \\ 0.682 & 0.6 & 0.441 & 1 & \\ 0.982 & 0.74 & 0.818 & 0.774 & 1 \end{bmatrix}$	5marks	15
7.	 Very by square and somewhat by under root	5 Marks	10

	AT T = 12; Cold is 0.6; Very Cold = square = 0.36; Somewhat cold is SQRT 0.6 about 0.76		
8.	 Two laws statement and proof – 2 marks each	1+2+2 =5	10
9.	Explaination 2 marks; Steps and final answer 3 marks  Final Answer 3m	2+3 =5	10
10.	 MOM 6.5 WA = 2.5*0.3 + 5*0.5+ 6.5*1 / 1.8 = (b) Centroid = Z* = 30	1+2+2 =5	15 min

Part C (2Q x 10M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
11	Full Detailed Mamdani Model Antecedant graphs; Consequent Graphs, Rule Sets; Methods for each operation titles; minimum 4 Cases application;	10 marks	30 min
12	a. $R_1 = \begin{bmatrix} 1 & 0.3 & 0 & 0.1 & 0.8 \\ 0.3 & 1 & 0.4 & 0 & 0.9 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.1 & 0 & 0 & 1 & 0.5 \\ 0.8 & 0.9 & 0 & 0.5 & 1 \end{bmatrix}$ Sagittal – 2 marks; Reflex yes; Symm yes; Transitive No; Toler Yes; Equivalence No b. (a) Only Fair (b) Only Good (c) c. 5'1" and 75kg	2+3 1+1+3	10 min +15min

HEIGHT → / WEIGHT ↓	SHORT .75	MEDIUM .25	TALL 0
LOW 0	Good	FAIR	POOR
MODERATE .25	FAIR .25	FAIR .25	GOOD
HIGH .75	POOR .75	POOR .25	FAIR

Consequent graph; Defuz