Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	FUZZY SYSTEM DEVELOPMENT
COURSE CODE	:	BIT 33703
PROGRAMME CODE	:	BIT
DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) What is fuzzy expert system?

(2 marks)

(b) **Table 1** provides the typical membership values of gain settings and sensor detection levels with a standard sensors.

Table 1: Gain setting for detection level of Sensor A and sensor B

Gain Setting	0	20	40	60	80	100
Detection Level (Sensor A)	0.00	0.50	0.65	0.85	1.00	1.00
Detection Level (Sensor B)	0.00	0.35	0.50	0.75	0.90	1.00

(i) Write the fuzzy sets of A and B.

(2 marks)

(ii) Find the fuzzy union, intersection and complement of two detection level of sensor ***A*** and sensor ***B***,

(6 marks)

Q2 Consider a fuzzy set P in the universe of x, whose membership function is given by

$$\mu_P(x) = 1-2|x-1| \quad \text{for } |x-1|<0.5$$
$$= 0 \quad \text{otherwise}$$

(a) Sketch the membership function for the set P.

(4 marks)

(b) What is the support set for P?

(2 marks)

(c) In the room temperature controller, the linguistic comfort range is defined on a temperature in ^{0}C as follows:

$$'Hot' = \{\frac{0}{25} + \frac{0.1}{26} + \frac{0.3}{27} + \frac{1.0}{28} + \frac{0.7}{29} + \frac{0.9}{30}\}$$

$$'Cold' = \{\frac{1}{25} + \frac{0.8}{26} + \frac{0.7}{27} + \frac{0.4}{28} + \frac{0.3}{29} + \frac{0.2}{30}\}$$

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Find the membership function for each of the following:

(i) Not very hot

(3 marks)

(ii) Slightly cold or slightly hot

(3 marks)

(iii) Not very very cold

(3 marks)

Q3 (a) Explain alpha-cut (α) for fuzzy relations.

(2 marks)

(b) Two fuzzy sets A and B are defined as follows:

$\mu(x_i)$	x_1	x_2	x_3	x_4	x_5	x_6
A	0.1	0.6	0.8	0.9	0.7	0.1
B	0.9	0.7	0.5	0.2	0.1	0.0

Find the fuzzy sets using the following α-cut,

(i) $(A \cup B)_{\alpha=0.6}$

(2 marks)

(ii) $(A \cap \bar{B})_{\alpha=0.7}$

(2 marks)

(iii) $\overline{(A \cap B)}_{\alpha=0.5}$

(4 marks)

Q4 (a) Find the fuzzy Cartesian product of fuzzy sets A and B with alpha-cut level of 0.3 and 0.8

$A=\{(x_1,0.2), (x_2,0.5), (x_3,1)\}$

$B=\{(y_1,0.3), (y_2,0.9)\}$

(5 marks)

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(b) In the field of computer networking, there is an imprecise relationship between the level of use of a network communication bandwidth and the latency experienced in peer-to-peer communication. Let $\tilde{A}$ be a fuzzy relation of the level use (percentage of full bandwidth used) and $\tilde{B}$ be a fuzzy relation of latencies (in milliseconds) with the following function:

$$A = \begin{bmatrix} 0.1 & 0.5 & 0.6 \\ 0.4 & 0.8 & 0.3 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0.4 & 0.8 \\ 0.6 & 0.5 \\ 1.0 & 0.8 \end{bmatrix}$$

Find the fuzzy relation between two fuzzy sets ***A*** and ***B***, using

(i) Max-min composition

(3 marks)

(ii) Max-product composition

(3 marks)

(iii) Max-average composition

(4 marks)

Q5 (a) What is defuzzification? Give **TWO (2)** methods of defuzzification.

(4 marks)

(b) A gas consumption is described by a set of two rules using fuzzy variables SPEED and DISTANCE. All the rules have to be satisfied simultaneously for the fuzzy output as shown in **Figure Q5(b)**. The rules are given as follows:

R1: IF `SPEED=SLOW(0.25)` AND DISTANCE=`FAR(0.82)`
THEN `GAS=DECREASE`

R2: IF `SPEED=MEDIUM(0.75)` OR DISTANCE=`NEAR(0.25)`
THEN `GAS=INCREASE`

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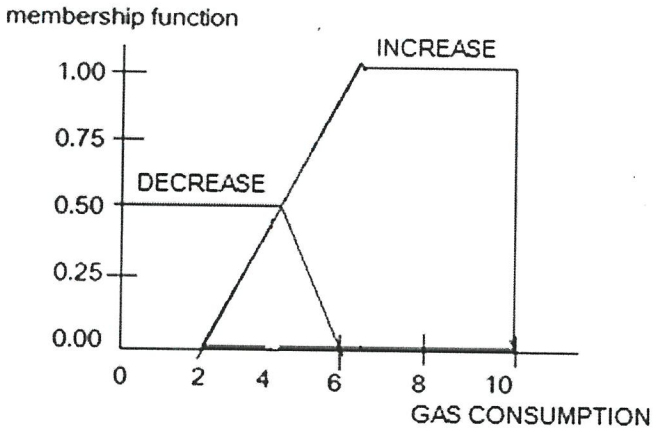

Figure Q5(b) Fuzzy output for gas consumption

(i) What is the fuzzy output?

(4 marks)

(ii) Calculate the centroid of the fuzzy output.

(6 marks)

(c) **Figure Q5(c)** shows a typical fuzzy output. Find the defuzzified values using

(i) Centroid method,

(3 marks)

(ii) Weighted average method.

(3 marks)

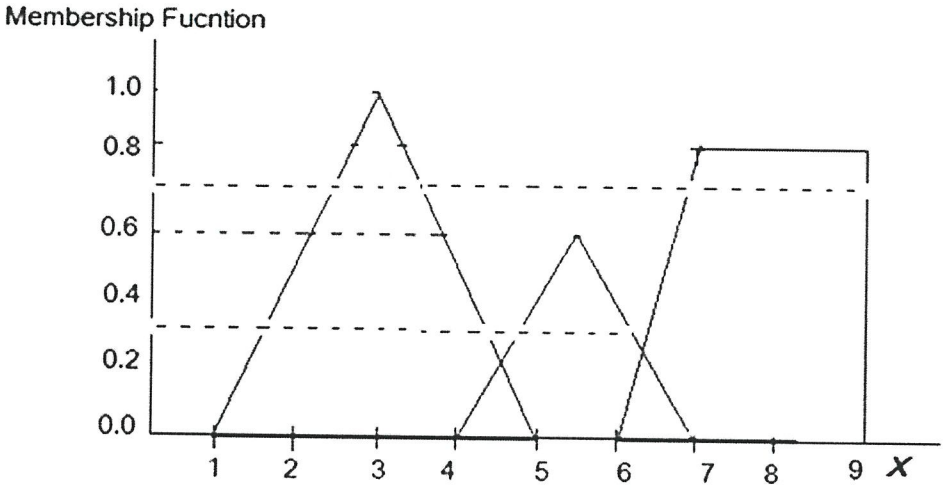

Figure Q5(c): Fuzzy output of the typical membership function

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Q6 UltraTech Company has two operational input factors Demand and Manufactured Cost to determine the product price for the company. **Table 2** shows the relation between the variables demand (in millions of units annually), manufactured cost (in RM per unit) and price (in cost per unit). The normalized membership function has been estimated as follows:

Table 2: the relation between the variables demand, manufactured cost and price

Input	Demand	Small =(1/100 , 0/300) Large=(0/150, 1/350)
	Manufactured Cost	Cheap=(1/10, 0/20) Expensive=(0/12, 1/24)
Output	Price	Low=(1/20, 0/35) Medium = (0/25, 1/35, 0/45) Large = (0/35, 1/50)

(a) Design a membership function graph for all the fuzzy inputs and output.

(3 marks)

(b) Construct rule based statements for the given situation.

(4 marks)

(c) If the demand forecast is 250 and the manufactured cost forecast is 15, calculate the forecast price needed by the company.

(8 marks)

Q7 Consider the following fuzzy expert system for weather forecast. The air pressure is measured in millibars, and the speed of its change in millibars per hour. The Membership diagram in **Figure Q7** represents the membership functions of two fuzzy variables describing the position of the arrow of barometer (left) and the direction of its movement (right):

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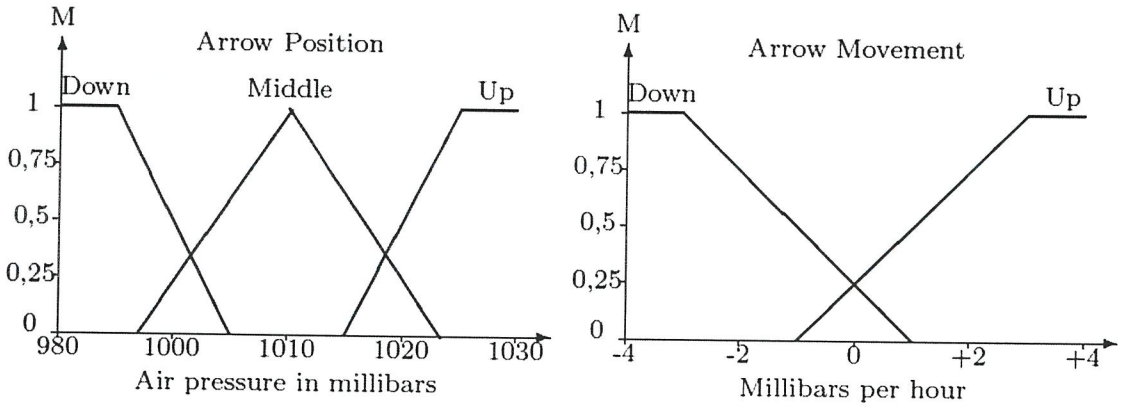

Figure Q7: Membership graph of position and direction arrow of Barometer

(a) Use the given membership diagram to find the values of:

(i) the arrow Down, Up or Middle of Arrow position if the pressure is 1020 millibars.

(3 marks)

(ii) the arrow moving Down or Up if the pressure changes -2 millibars every hour.

(3 marks)

(b) Use the membership values found above and confidences of the rules in the **Table 3** to calculate the degree of confidence of the sky is clear or cloudy.

Table 3: Confidence of Rules

Rule	Condition	Action	Confidence
R1:	IF *arrow is down*	THEN *clouds*	$M = 0.8$
R2:	IF *arrow is in the middle* AND *moving down*	THEN *clouds*	$M = 0.6$
R3:	IF *arrow is in the middle* AND *moving up*	THEN *sunny*	$M = 0.6$
R4:	IF *arrow is up*	THEN *sunny*	$M = 0.8$

(9 marks)

- **END OF QUESTIONS** -

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