



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2021/2022**

COURSE NAME : FUZZY SYSTEM DEVELOPMENT  
COURSE CODE : BIT 33703  
PROGRAMME CODE : 3 BIT  
EXAMINATION DATE : JANUARY / FEBRUARY 2022  
DURATION : 3 HOURS  
INSTRUCTION : 1. ANSWERS ALL QUESTIONS.

2. THIS FINAL EXAMINATION IS  
CONDUCTED ONLINE AND  
CLOSE BOOK.

**TERBUKA**

THIS QUESTION PAPER CONSISTS OF FOUR (4) PAGES

- Q1** Consider a universe of discourse of A is  $X = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ . The membership function defined as  $\mu_A(x) = x / (x + 2)$ . Find the  $\alpha$ -cut that corresponding to  $\alpha = 0.5$ . (2 marks)

- Q2** Let  $X$  be the universe of commercial aircraft of interest;  
 $X = \{a10, b52, b117, c5, c130, f4, f14, f15, f16, f111, kc130\}$

Let  $A$  be the fuzzy set passenger class aircraft;

$$A = \left\{ \frac{0.3}{f16}, \frac{0.5}{f4}, \frac{0.4}{a10}, \frac{0.6}{f14}, \frac{0.7}{f111}, \frac{1.0}{b117}, \frac{1.0}{b52} \right\}$$

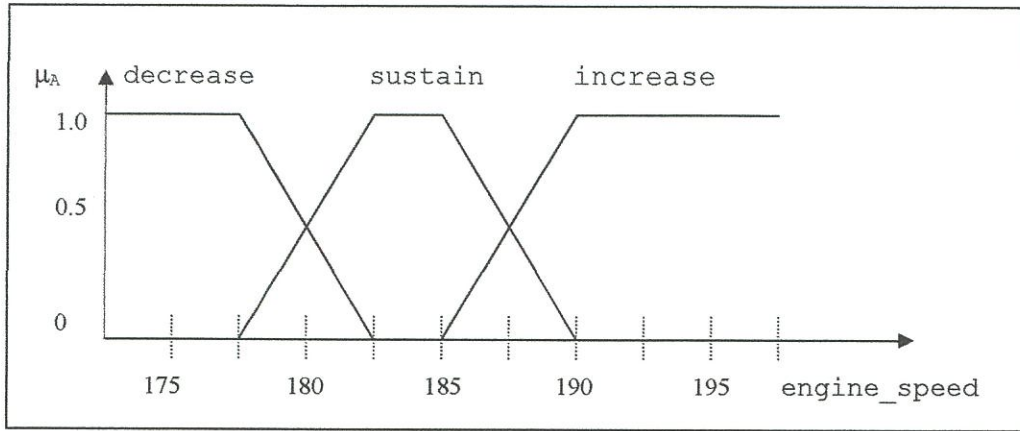
Let  $B$  be the fuzzy set of cargo,

$$B = \left\{ \frac{0.4}{b177}, \frac{0.4}{f111}, \frac{0.6}{f4}, \frac{0.8}{f15}, \frac{0.9}{f14}, \frac{1.0}{f16} \right\}$$

Find the following membership functions using standard fuzzy operations.

- (a)  $\mu_A \cup \mu_B(x)$  (4 marks)
- (b)  $\mu_A \cap \mu_B(x)$  (4 marks)
- (c)  $\mu_{\bar{A}}(x)$  (4 marks)
- (d)  $\mu_{\bar{B}}(x)$  (4 marks)

**Q3** Questions **Q3(a)** – **Q3(c)** are based on **Figure Q3**.



**Figure Q3**

- (a) Identify and write the linguistic variable and the linguistic value. (4 marks)
- (b) Write the fuzzy set expression for the fuzzy membership functions of engine\_speed (8 marks)
- (c) **Figure Q3** shows the membership functions of engine\_speed. Explain using the membership graph and calculate the Center of Gravity defuzzification process. Given the DECREASE=0.2, SUSTAIN=0.8 and INCREASE=0.5. (12 marks)

**Q4** SavvyCorp is manufacturing a new washing machine and has created the Fuzzy Associative Matrix as illustrated in **Table 1** to relate dirt\_type and dirt\_level to wash\_time. The following trapezoidal/ triangular normalized membership functions have been estimated:

**Table 1: Fuzzy Associative Matrix**

Dirty Type \ Dirtiness Level	Less dirty	Dirty	Very Dirty	Extremely Dirty
Non-greasy	very short	short	medium	long
Less greasy	short	medium	long	long
Greasy	medium	medium	long	very long
Very greasy	long	long	very long	very long



**Table 2:** cycle\_time

Variable	Categories	Range
<b>Dirty Type</b>	Less dirty	Less than 25
	Dirty	20 to 30
	Very Dirty	25 to 35
	Extremely Dirty	Greater than 30
<b>Dirtiness Level</b>	Non-greasy	Less than 20%
	Less greasy	15% to 40%
	Greasy	25% to 60%
	Very greasy	Greater than 55%
<b>Washing Time</b>	very short	Less than 30 minutes
	short	25 to 45 minutes
	medium	40 to 60 minutes
	long	55 to 75 minutes
	very long	60 to 90 minutes

- (a) Design a fuzzy system which accommodates the given situation. (4 marks)
- (b) Based on **Table 2**, write the fuzzy set expression for the following fuzzy variable
- (i) dirt\_type (8 marks)
- (ii) dirt\_level (8 marks)
- (iii) wash\_time (10 marks)
- (c) Based on answer in **Q4(b)**, draw the membership function graph for fuzzy variable dirt\_type, dirt\_level and wash\_time. (12 marks)
- (d) Construct the rule base statements for the given situation. (16 marks)

- END OF QUESTIONS -