



**KOLEJ UNIVERSITI TEKNOLOGI TUN
HUSSEIN ONN**

**PEPERIKSAAN AKHIR
SEMESTER I
SESI 2006/07**

NAMA MATAPELAJARAN : SISTEM KAWALAN FUZZY
KOD MATAPELAJARAN : BTE 4413
KURSUS : 4 BTR
TARIKH PEPERIKSAAN : NOVEMBER 2006
JANGKAMASA : 3 JAM
ARAHAN : JAWAB **SEMUA** SOALAN
BAHAGIAN A DAN MANA-MANA
DUA (2) SOALAN DARIPADA
BAHAGIAN B.

BAHAGIAN A

- S1** (a) Lakar dan terangkan rajah asas bagi sistem kawalan kabur. (8 markah)
- (b) Jelaskan maksud logik kabur secara perbandingan dengan logik klasik. (8 markah)
- (c) Semua operasi pada set klasik juga memegang set kabur kecuali Aksioma-Pertengahan Terkecuali (Excluded Middle-Axiom). Lakarkan rajah Venn yang menunjukkan kedua-dua perbezaan ini. (8 markah)
- (d) Lakar dan huraikan semua sifat-sifat fungsi keanggotaan. (8 markah)
- (e) Berikan takrifan ringkas bagi yang berikut:
- (i) Set Kabur Normal.
 - (ii) Set Kabur Cembung.
 - (iii) Titik Persilangan.
 - (iv) Proses Pengaburan.
- (8 markah)
- S2** (a) Bina sebuah sistem kawalan kabur yang mempunyai dua masukan dan satu keluaran. Lakarkan keseluruhan sistem tersebut berdasarkan FIS Editor. (20 markah)

BAHAGIAN B

S3 (a) Diberi

$$\underline{A} = \left\{ \frac{0.2}{x} + \frac{0.5}{y} + \frac{0.9}{z} \right\}.$$

Dapatkan set potongan- λ bagi $\lambda = 0.91, 0.66, 0.29$, dan 0.01 .

(4 markah)

(b) Sebuah stesen janakuasa sedang melakukan ujian terhadap sistem penjanaan mereka dengan menggunakan gas asli, disel dan arang batu. Tiga sampel set X_1, X_2 dan X_3 seperti Rajah S3(b) diambil dan diuji untuk mendapatkan keluaran tenaga elektrik yang maksimum. Lakarkan dan dapatkan persembahan terhampir (z^*) untuk kesemua sampel dengan menggunakan:

- (i) Prinsip keanggotaan maksimum.
- (ii) Kaedah titik tengah.
- (iii) Kaedah pemberat purata.
- (iv) Keanggotaan purata maksimum.
- (v) Titik tengah perjumlahan.
- (vi) Titik tengah kawasan terluas.
- (vii) Maksimum pertama (atau terakhir).

(16 markah)

S4 (a) Bagi rajah Sagittal dalam Rajah S4(a), dapatkan:

- (i) Hubungan R (unsur pemetaan dari X ke Y).
- (ii) Hubungan S (unsur pemetaan dari Y ke Z).
- (iii) Hubungan matrik bagi R dan S.
- (iv) Hubungan T menggunakan komposisi maks-maks.
- (v) Hubungan T menggunakan komposisi maks-min.

(8 markah)

(b) Buktikan kenyataan berikut menggunakan tautologi dan percanggahan.

- (i) $((P \rightarrow \bar{Q}) \wedge (Q \vee \bar{R})) \rightarrow \bar{P}$
- (ii) $((P \rightarrow Q) \wedge (Q \rightarrow R)) \rightarrow (P \rightarrow R)$

(12 markah)

- S5 (a) Diberi dua set kabur yang ditakrifkan pada semesta $X = \{-1, 3\}$

$$\text{Voltan Tinggi} = \left\{ \frac{0.9}{-1} + \frac{0.3}{0} + \frac{0.6}{1} + \frac{0.5}{2} + \frac{0.1}{3} \right\}$$

$$\text{Arus Rendah} = \left\{ \frac{1}{-1} + \frac{0.5}{0} + \frac{0.7}{1} + \frac{0.4}{2} \right\}$$

Gunakan kaedah *Linguistic Hedges* bagi mendapatkan hubungan berikut:

- (i) "Very" Voltan Tinggi atau "Moderate" Arus Tinggi.
- (ii) "Plus" Voltan Rendah dan "Slightly" Arus Tinggi
- (iii) "Not Very-very" Arus Tinggi

(10 markah)

- (b) Bina algoritma bagi bentuk fungsi keanggotaan yang berikut:

- (i) Segitiga
- (ii) Gaussian
- (iii) Trapezoid

(10 markah)

- S6 (a) Pertimbangkan dua set kabur diskrit dibawah, yang ditakrifkan pada semesta $X = \{-2, 2\}$

$$\underline{A} = \text{"tinggi"} = \left\{ \frac{0}{-2} + \frac{0.5}{-1} + \frac{1}{0} + \frac{0.5}{1} + \frac{0}{2} \right\}$$

$$\underline{B} = \text{"rendah"} = \left\{ \frac{1}{-1} + \frac{0.5}{0} + \frac{0.5}{1} + \frac{0.3}{2} \right\}$$

Bina hubungan bagi aturan JIKA A, MAKA B menggunakan:

- (i) Aturan 1: $\mu_{\underline{R}}(x, y) = \max[(\mu_{\underline{A}}(x) \wedge \mu_{\underline{B}}(y)), (1 - \mu_{\underline{A}}(x))]$
- (ii) Aturan 2: $\mu_{\underline{R}}(x, y) = \max[\mu_{\underline{B}}(y), (1 - \mu_{\underline{A}}(x))]$

(14 markah)

- (b) Jika satu maklumat yang baru diperkenalkan,

$$\underline{A}' = \text{"di tengah"} = \left\{ \frac{0}{-1} + \frac{0.5}{0} + \frac{0.4}{1} + \frac{0.3}{2} \right\}$$

Dapatkan hasil baru \underline{B}' , dengan menggunakan komposisi maks-min bagi kedua-dua hubungan dari S6 (a).

(6 markah)

SOALAN DALAM BAHASA INGGERIS

SECTION A

- Q1**
- (a) Sketch and explain the basic diagram of fuzzy control system. (8 marks)
 - (b) Describe the definition of fuzzy logic by comparing with classical logic. (8 marks)
 - (c) All other operations on classical sets hold for fuzzy sets except the Excluded Middle-Axioms. Draw the Venn diagram to show both differences. (8 marks)
 - (d) Sketch and describe all the features of the membership function. (8 marks)
 - (e) Give a brief definition for the following:
 - (i) Normal Fuzzy Sets.
 - (ii) Convex Fuzzy Sets.
 - (iii) Crossover points.
 - (iv) Fuzzification process. (8 marks)
- Q2**
- (a) Build a fuzzy control system with two inputs and an output. Sketch the overall system based on FIS Editor. (20 marks)

SECTION B

Q3 (a) Given

$$\underline{A} = \left\{ \frac{0.2}{x} + \frac{0.5}{y} + \frac{0.9}{z} \right\}.$$

Find the λ -cut sets for $\lambda = 0.91, 0.66, 0.29,$ and 0.01 .

(4 marks)

(b) A power-generation station is currently doing a test for their generator system using natural gas, diesel and coal. Three sample sets, X_1, X_2 and X_3 as illustrated in Figure Q3(b) are taken and tested to get the maximum output power. Sketch and find the most nearly representative (z^*) for all samples using:

- (i) Max membership principle.
- (ii) Centroid method.
- (iii) Mean max membership.
- (iv) Weighted average method.
- (v) Centre of sums.
- (vi) Centre of largest area.
- (vii) First (or last) of maxima.

(16 marks)

Q4 (a) For the Sagittal diagram in Figure Q4(a), find:

- (i) R relation (mapping element from X to Y).
- (ii) S relation (mapping element from Y to Z).
- (iii) The matrix relation of R and S.
- (iv) T relation using max-max composition.
- (v) T relation using max-min composition.

(8 marks)

(b) Prove the following statements using tautologies and contradictions.

- (i) $((P \rightarrow \bar{Q}) \wedge (Q \vee \bar{R})) \rightarrow \bar{P}$
- (ii) $((P \rightarrow Q) \wedge (Q \rightarrow R)) \rightarrow (P \rightarrow R)$

(12 marks)

- Q5** (a) Given two fuzzy sets which are defined on universe $X = \{-1, 3\}$

$$\text{High Voltage} = \left\{ \frac{0.9}{-1} + \frac{0.3}{0} + \frac{0.6}{1} + \frac{0.5}{2} + \frac{0.1}{3} \right\}$$

$$\text{Low Current} = \left\{ \frac{1}{-1} + \frac{0.5}{0} + \frac{0.7}{1} + \frac{0.4}{2} \right\}$$

Use Linguistic Hedges method to find the following relation:

- (i) "Very" High Voltage or "Moderate" High Current
- (ii) "Plus" Low Voltage and "Slightly" High Current
- (iii) "Not Very-very" High Current

(10 marks)

- (b) Develop algorithms for the following membership function shapes:

- (i) Triangular
- (ii) Gaussian
- (iii) Trapezoid

(10 marks)

- Q6** (a) Consider the following two discrete fuzzy sets, which are defined on universe $X = \{-2, 2\}$

$$\underline{A} = \text{"high"} = \left\{ \frac{0}{-2} + \frac{0.5}{-1} + \frac{1}{0} + \frac{0.5}{1} + \frac{0}{2} \right\}$$

$$\underline{B} = \text{"low"} = \left\{ \frac{1}{-1} + \frac{0.5}{0} + \frac{0.5}{1} + \frac{0.3}{2} \right\}$$

Construct the relation for rule IF A, THEN B using:

- (i) Rule 1: $\mu_{\underline{R}}(x, y) = \max[(\mu_{\underline{A}}(x) \wedge \mu_{\underline{B}}(y)), (1 - \mu_{\underline{A}}(x))]$
- (ii) Rule 2: $\mu_{\underline{R}}(x, y) = \max[\mu_{\underline{B}}(y), (1 - \mu_{\underline{A}}(x))]$

(14 marks)

- (b) If a new antecedent is introduced as,

$$\underline{A}' = \text{"intermediate"} = \left\{ \frac{0}{-1} + \frac{0.5}{0} + \frac{0.4}{1} + \frac{0.3}{2} \right\}$$

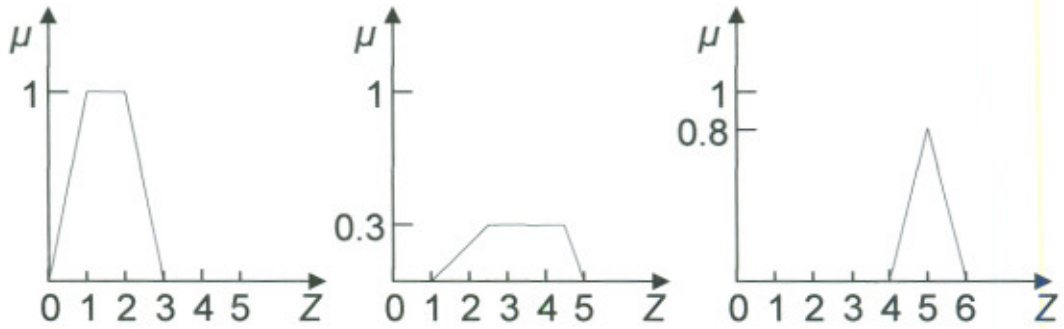
Find the new consequent \underline{B}' , by using max-min composition for both relations from Q6(a).

(6 marks)

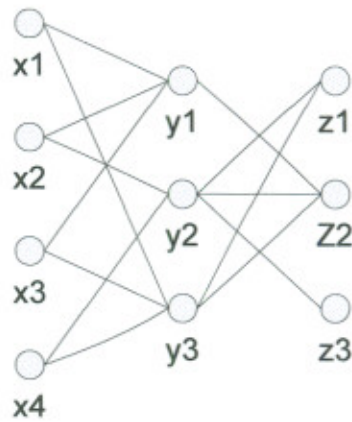
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Rajah S3(b)/Figure Q3(b)



Rajah S4(a)/Figure Q4(a)