國 立 臺 北 科 技 大 學

102 學年第一學期電機系博士班資格考試

模糊控制 試題

注意事項：

1. 本試題共【5】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。
4. 考試時間:二小時。
5. 不准使用任何形式之計算器。

1. Suppose that a fuzzy subset B is defined by $B = \frac{0.2}{a} + \frac{0.4}{b} + \frac{0.7}{c} + \frac{1}{d}$. (a) Find α-level set (or α-cut) of B when α=0.3 and α=0.7. (b) How to reconstruct the fuzzy subset of B from the α-level sets? (10 分)
2. Suppose we want to design a fuzzy system to balance the inverted pendulum shown in Fig. 1. Let the angle θ and its derivation be the inputs to the fuzzy system and the force u applied to the cart be its output. Design a fuzzy system based on the common sense to balance the inverted pendulum. (20 分)

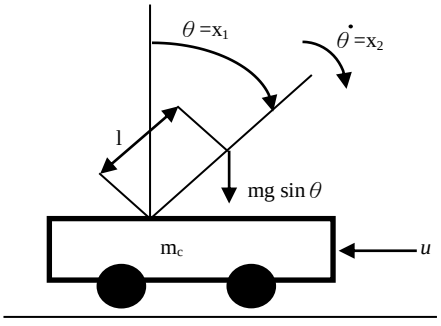

Fig. 1. The inverted pendulum system.

3. Design a fuzzy controller for washing machines. If inputs $x \in [0,20]$ and $y \in [0,5]$ represent the weight and ingredient of to-be-washed clothes, respectively. The corresponding output of this controller is the time (minutes) $t \in [0,60]$ required to clean the clothes. Assume there were 500 data, $(x_i, y_i; t_i)$, $i \in [0,500]$, collected from different experiments before designing

such a system. (a) How to derive the initial membership functions for input and output variables? (b) How to adjust the initial membership functions to achieve a feasible controller? (c) Approximately how may rules in your fuzzy rule base? Why? (25 分)

4. Suppose that the process in Fig. 2 is modeled by a second-order dynamic TSK fuzzy system that is constructed from the following two rules:

   L^1: IF $x(k)$ is A_1^1 and $x(k-1)$ is A_2^1 and $u(k)$ is B^1,

   THEN $x^1(k+1) = 1.5x(k) + 2.1x(k-1) - u(k)$.

   L^2: IF $x(k)$ is A_1^2 and $x(k-1)$ is A_2^2 and $u(k)$ is B^2,

   THEN $x^2(k+1) = 0.3x(k) - 3.4x(k-1) + 0.5u(k)$.

   And that the controller in Fig. 2 is a TSK fuzzy system constructed from the following two rules:

   R^1: IF $x(k)$ is C_1^1 and $x(k-1)$ is C_2^1, THEN $u^1(k) = k_1^1 x(k) + k_2^1 x(k-1)$.

   R^2: IF $x(k)$ is C_1^2 and $x(k-1)$ is C_2^2, THEN $u^2(k) = k_1^2 x(k) + k_2^2 x(k-1)$.

   Design a closed-loop fuzzy control system from the dynamic TSK fuzzy system. (25 分)

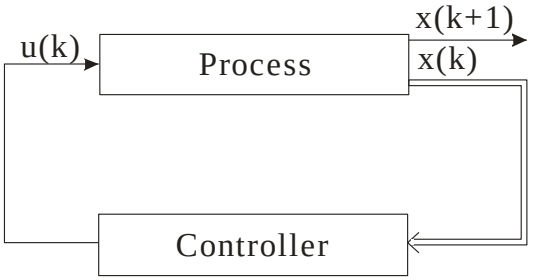

Fig. 2. Fuzzy control of fuzzy system model.

5. Assuming there are only two rules in a fuzzy rule base:

   Rule 1: If X is A_1 and Y is B_1, then Z is C_1,

   Rule 2: If X is A_2 and Y is B_2, then Z is C_2.

   Also assuming $x_0=4$ and $y_0=6$ are sensor readings for input variables X and Y, respectively. (a) Determine the antecedent firing strength of each rule and find the defuzzified output based on the following membership functions. (b) If the consequent parts of rule 1 and rule 2 become Z=0.3(X+Y) and Z=0.4X+0.3Y+2, respectively. Find the defuzzified output and compare it with the results derived in part (a). (20 分)

$$\mu_{A1} = \begin{cases} \frac{x-2}{3}, 2 \le x \le 5 \\ \frac{8-x}{3}, 5 < x \le 8 \end{cases} \quad \mu_{A2} = \begin{cases} \frac{x-3}{3}, 3 \le x \le 6 \\ \frac{9-x}{3}, 6 < x \le 9 \end{cases}$$

$$\mu_{B1} = \begin{cases} \frac{y-5}{3}, 5 \le y \le 8 \\ \frac{11-y}{3}, 8 < y \le 11 \end{cases} \quad \mu_{B2} = \begin{cases} \frac{y-4}{3}, 4 \le y \le 7 \\ \frac{10-y}{3}, 7 < y \le 10 \end{cases}$$

$$\mu_{C1} = \begin{cases} \frac{z-1}{3}, 1 \le z \le 4 \\ \frac{7-z}{3}, 4 < z \le 7 \end{cases} \quad \mu_{C2} = \begin{cases} \frac{z-3}{3}, 3 \le z \le 6 \\ \frac{9-z}{3}, 6 < z \le 9 \end{cases}$$