

Fuzzy Control
Qualification Exam. in EE, NTUT

date: 2008/5/27 (不得用計算器, Closed book)

(1) Please find the height and 0.6-cut of the following fuzzy sets respectively. By the way, the 0.6-cut is a fuzzy or crisp set? (15%)

(a) $A = 0.4/a + 0.5/b + 0.6/c + 0.8/d + 1/e$

(b) $B = 1/\alpha + 1/\beta + 1/\gamma$

(c) $C(x) = \frac{x}{x+2}$, where $x \in \{0, 1, 2, \dots, 10\} = X$.

(2) Please find $A+B$ and $A \cup B$ (standard union), where fuzzy numbers A and B are as follows.(10%)

$$A = 0/0 + 0.1/1 + 0.3/2 + 0.8/3 + 1/4 + 0.7/5 + 0.3/6 + 0/7 + 0/8 + \dots$$

$$B = 0/0 + 0.3/1 + 0.6/2 + 1/3 + 0.7/4 + 0.2/5 + 0.1/6 + 0/7 + 0/8 + \dots$$

(3) Please find $W = P \cdot Q$, where \cdot is Max-min composition, $P(x,y)$ and $Q(y,z)$ are 2 dimension fuzzy relation. Find the projections $\{W \downarrow X\} \{X\}$ and $\{W \downarrow Z\} \{Z\}$. (20%)

$$P = \begin{bmatrix} 1 & 0.7 & 0.5 \\ 0.7 & 1 & 0.5 \\ 0.5 & 0.5 & 1 \end{bmatrix}, \quad Q = \begin{bmatrix} 0.2 & 0.7 & 0.4 \\ 0.1 & 0.5 & 0 \\ 0 & 0.6 & 0.1 \end{bmatrix}$$

(4) What is the T-S fuzzy model? Give an example. How to check the stability of the fuzzy T-S fuzzy system. Please write all what you know. (10%)



(5) Please explain what is "Universal Approximation Theorem"? Design a fuzzy system $f(x)$ to approximate the function $g(x) = \cos x$ on $U = [-3, 3]$ with a required accuracy $\epsilon = 0.11$, i.e. $\|g - f\|_\infty < 0.15$. Your answer should at least contain how many rules? What is the form of $f(x)$? Please write your answer as detailed as possible. (25%)

- (6) We like to control an inverted pole, the fuzzy input variables are $(\theta, \dot{\theta})$ and the output variable is u . Their fuzzy sets are shown in Fig. 5. The control rule table is shown in Table 5. Please use Minimum Inference Engine and Center of Gravity Defuzzification to find the control output U , while the singleton input is $(\theta=7, \dot{\theta}=8)$. (20%)

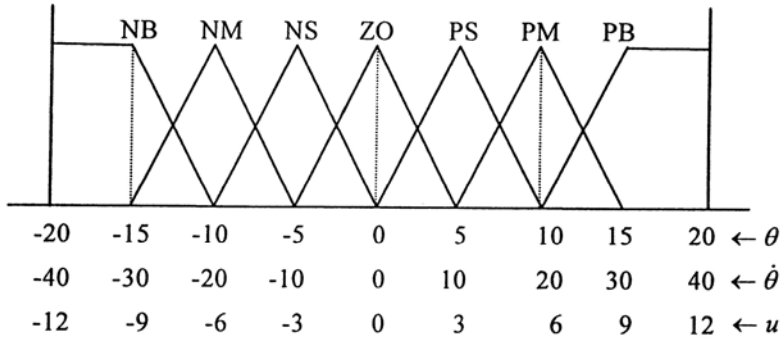


Fig.5

Table 5

$\theta \backslash \dot{\theta}$	NB	NM	NS	ZO	PS	PM	PB
NB	NB	NB	NB	NB	NM	NM	NS
NM	NB	NB	NM	NM	NS	ZO	ZO
NS	NB	NM	NS	NS	ZO	PS	PM
ZO	NB	NM	NS	ZO	PS	PM	PB
PS	NM	NS	ZO	PS	PS	PM	PB
PM	ZO	ZO	PS	PM	PM	PB	PB
PB	PS	PM	PM	PB	PB	PB	PB

