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Soft Computing Techniques (Assignment 2)

) Design a fuzzy control system for Washing Machine. inorder to determine the Wash Time.

lution.

I) Input Variables.

① Dirt (on clothes): High dirt (D_3), Medium Dirt (D_2)
Low dirt (D_1)

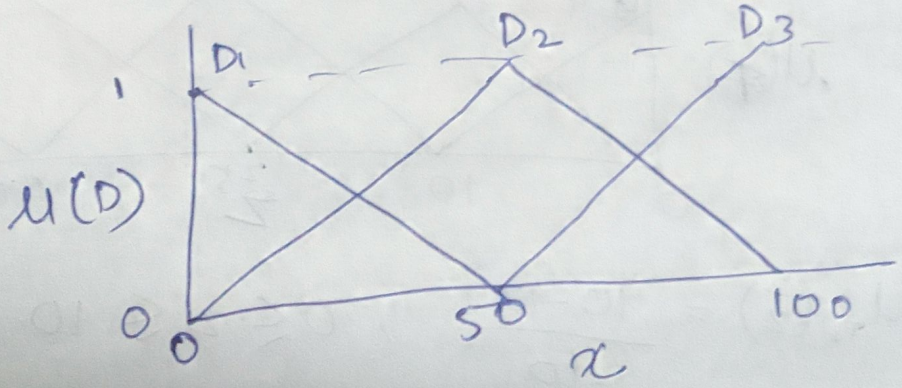
② Grease (on clothes): High Grease (G_3), Medium Grease (G_2)
Low Grease (G_1)

) Output Variables:

Wash Time: Very High (T_5), ~~Medium~~ High (T_4)
Medium (T_3), short (T_2),
Very short (T_1).

i) Defining membership function for i/p variable

① For dirt:



i) $\mu_{D_1} = \frac{50 - x}{50}$, $0 \le x \le 50$

ii) $\mu_{D_2} = \frac{x}{50}$, $0 \le x \le 50$

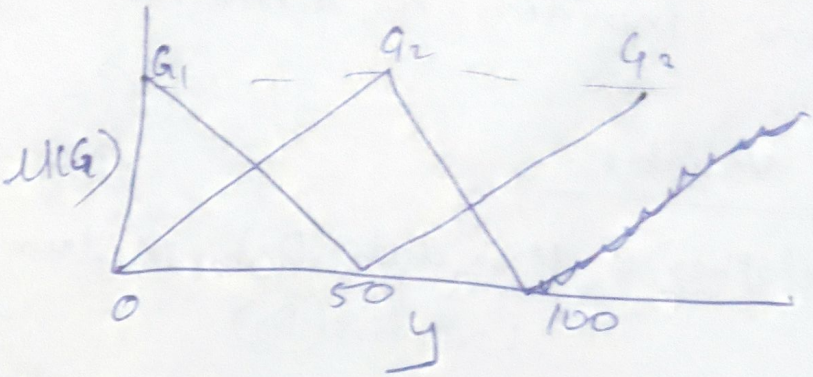
$= \frac{100 - x}{50}$, $50 \le x \le 100$

iii) $\mu_{D_3}(x) = \frac{x-50}{50}$, $50 \le x \le 10$

iii) ✓

② For greese.

iv).



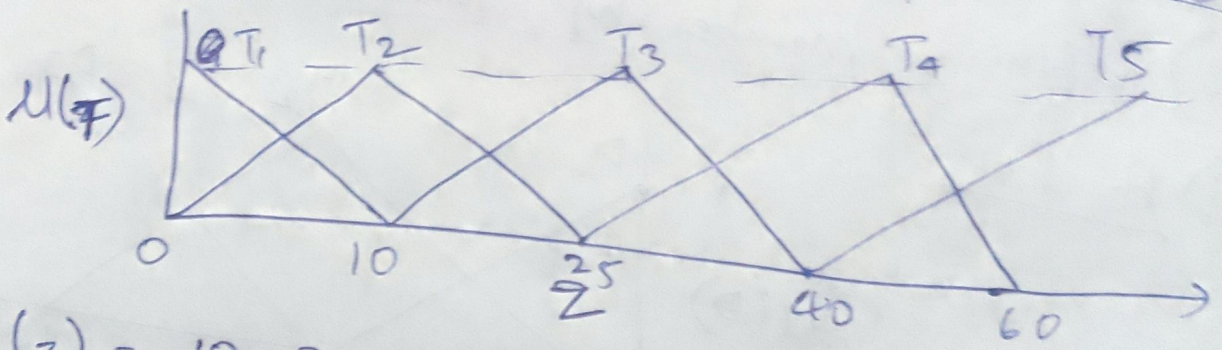
v) i) $\mu_{G_1}(y) = \frac{50-y}{50}$, $0 \le y \le 50$

ii) $\mu_{G_2}(G) = \frac{y}{50}$, $0 \le y \le 50$

v) $= \frac{100-y}{50}$, $50 \le y \le 100$

iii) $\mu_{G_3}(y) = \frac{y-50}{50}$, $50 \le y \le 100$

IV Defining Membership function for o/p variable



i) $\mu_{T_1}(z) = \frac{10-z}{10}$, $0 \le z \le 10$

ii) $\mu_{T_2}(z) = \frac{z}{10}$, $0 \le z \le 10$

$= \frac{25-z}{15}$, $10 \le z \le 25$

Wash time

iii) $\mu_{T_3}(z) = \frac{z-10}{15}$ $\quad 10 \leq z \leq 25$

$= \frac{40-z}{15}$ $\quad 25 \leq z \leq 40$

iv) $\mu_{T_4}(z) = \frac{z-25}{15}$ $\quad 25 \leq z \leq 40$

$= \frac{60-z}{20}$ $\quad 40 \leq z \leq 60$

v) $\mu_{T_5}(z) = \frac{z-40}{20}$, $\quad 40 \leq z \leq 60$

V) Control Rules for our Fuzzy controller

	G_1	G_2	G_3
D_1	T_1	T_3	T_4
D_2	T_2	T_3	T_4
D_3	T_3	T_4	T_5

∴ Rules can be define as

i) If Dirt is D_1 and Grease is G_1 then Wash Time is T_1

ii) If Dirt is D_1 and Grease is G_2 then Wash Time is T_3

iii) If Dirt is D_1 and Grease is G_3 then Wash time is T_4

iv) If Dirt is D_2 and Grease is G_1 then Wash Time is T_2.

v) If dirt is D_2 and Grease is G_2 then Wash Time is T_3

vi) If dirt is D_2 and Grease is G_3 then Wash Time is T_4

vii) If dirt is D_3 and Grease is G_1 then Wash Time is T_3

viii) If dirt is D_3 and Grease is G_2 then Wash Time is T_4

ix) If dirt is D_3 and Grease is G_3 then Wash Time is T_5

VI) Test Cases (Examples)

1) Assume Dirt is 60% & Grease is 70%.

Soln i) Converting Crisp to Fuzzy value. (Fuzzification)

Here Since Dirt = 60%.

& Grease = 70%

there are 2 membership function applicable.

$$\mu_{D_2}(x) = \frac{100-x}{50} = \frac{100-60}{50} = \frac{40}{50} = 0.8$$

and

$$\mu_{D_3}(x) = \frac{x-50}{50} = \frac{60-50}{50} = \frac{10}{50} = 0.2$$

$$\mu_{G_2}(y) = \frac{100-y}{50} = \frac{100-70}{50} = \frac{30}{50} = 0.6$$

and

$$\mu_{G_3}(y) = \frac{y-50}{50} = \frac{70-50}{50} = \frac{20}{50} = 0.4$$

0.1 dirt membership value of 13 lb

Now Converting the membership values to linguistic term.

0.8 => Medium Dirt => D_2

0.2 => High Dirt => D_3

0.6 => Medium Grease => G_2

0.4 => High Grease = G_3

Evaluation all possibilites for Defuzzification using Mean Max method:

i)	D_2	G_2	Min (D_2, G_2) = Min(0.8, 0.6) = 0.6
ii)	D_2	G_3	Min (D_2, G_3) = Min(0.8, 0.4) = 0.4
iii)	D_3	G_2	Min (0.2, 0.6) = 0.2
iv)	D_3	G_3	Min(0.2, 0.4) = 0.2

∴ Max (0.6, 0.4, 0.2, 0.2) = 0.6

∴ Here we will select D_2 & G_2 for evaluation

We have define rule 1 for D_2 & G_2 evaluation.

∴ If dirt is D_2 & grease is G_2 then Wash Time is T_3

∴ Evaluation membership value of T_3 to find wash time

$\therefore \mu_{T_3}(z) = \frac{z-10}{15}$ & $\mu_3(z) = \frac{40-z}{15}$

$0.6 = \frac{z-10}{15}$ & $0.6 = \frac{40-z}{15}$

$(0.6 \times 15) + 10 = z$ & $(0.6 \times 15) + z = z$

$\therefore \boxed{z = 19}$ & $\boxed{z = 31}$

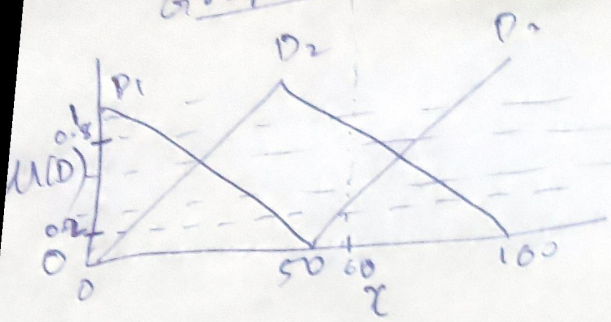
Here we can take average of these two val.

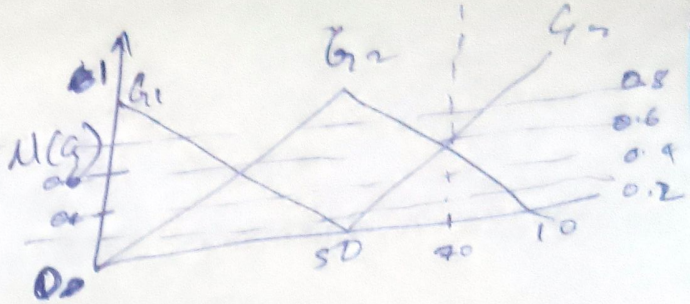
$\therefore z^* = \frac{19+31}{2} = 25$ min

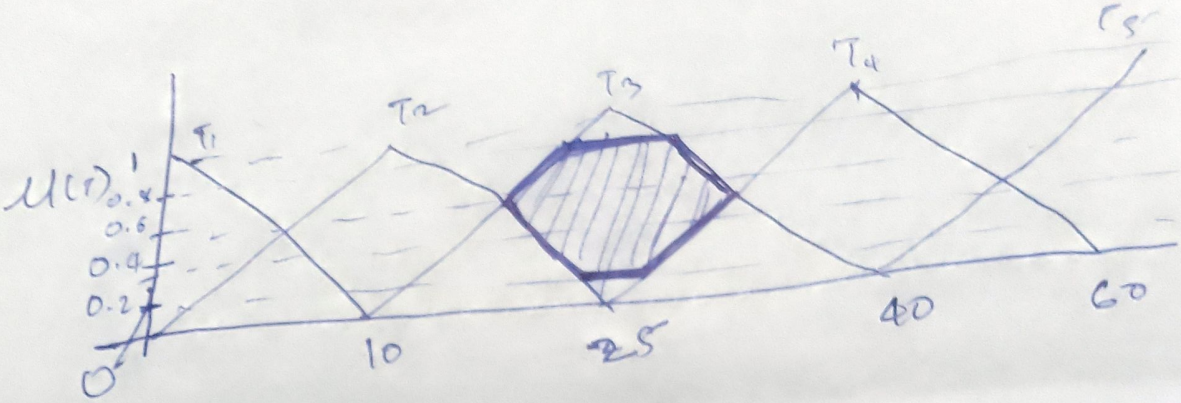
$\therefore \boxed{T_3 = 25 \text{ min}}$

Hence the time required is 25 min.

Graphically







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