Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Computer Science and Technology
400 level 1st Semester Examination – Jul./Aug. 2016
CST453-2 Fuzzy Logic & Fuzzy Controllers

Uva Wellassa University

Instructions to candidates:
Duration: Two (02) hours
Number of questions: Four (04)
Answer all questions
Mark allocation: 100

1.

a. Distinguish between the fuzzy logic and crisp logic based on the truth values of variables. (4 mark)

b. Explain how fuzzy logic differs from probability using an appropriate example. (6 mark)

c. Suppose you are requested to evaluate students' performance based on two distinct parameters, their competency in studies and sports. A fuzzy membership function **F{A(x)}** is defined for being good with studies. A second fuzzy membership function **F{B(x)}** is mapped for being good in sports. Interpret the literal meaning of the following statements:

i. $F\{A \cap B(x)\} = \min [F\{A(x)\}, F\{B(x)\}]$

ii. $F\{A \cup B(x)\} = \max [F\{A(x)\}, F\{B(x)\}]$

iii. $F\{A'(x)\} = 1 - F\{A(x)\}$ (9 mark)

d. Critically analyze the validity of the following properties in the context of fuzzy sets:

i. The laws of contradiction

$A \cap \bar{A} = \emptyset$ (3 mark)

ii. The laws of exclude middle

$A \cup \bar{A} = U$ (3 mark)

2.

a. A motor attached to the pulsator (rotating component) of a washing machine is driven based on the input fuzzy membership function (weight of cloth), as illustrated in figure below (Fig.01).

(48) (7)

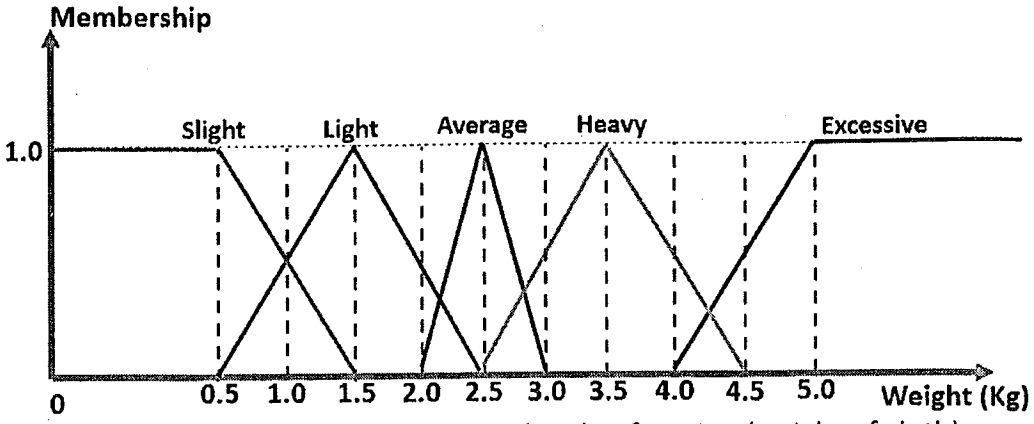

Figure 01: Input fuzzy membership function (weight of cloth)

The following set of fuzzy rules are used to determine the rpm (revolutions per minute) of the motor:

- IF **Slight** then **Stop**
- IF **Light** then **Slow**
- IF **Average** then **Medium**
- IF **Heavy** then **Fast**
- IF **Excessive** then **Blast**

The corresponding rpm values for each input value is referred from an output fuzzy membership function as given in Fig.02.

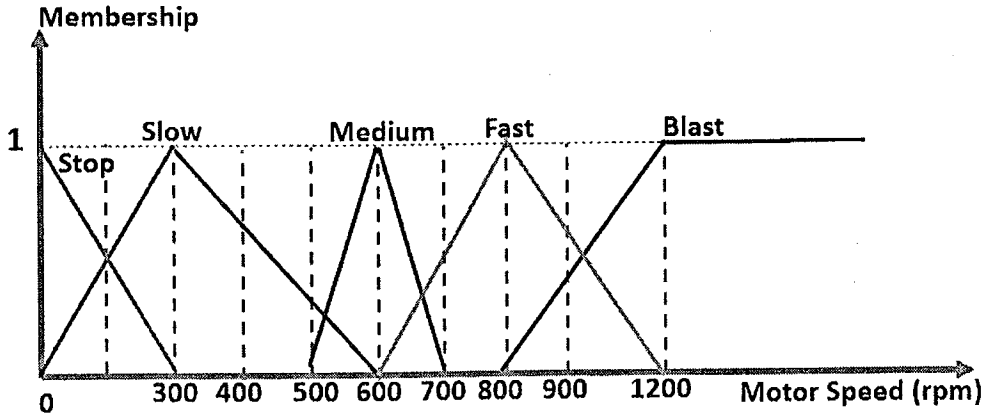

Figure 02: Output fuzzy membership function (speed of the motor)

Find the corresponding rpm of the motor for the following cloth weights:

i. 0.25 Kg
ii 1.25 Kg
iii. 2.25 Kg
iv. 4.25 Kg
v. 5.25 Kg

(15 mark)

b. Explain how to compute the output fuzzy value when there are more than one (01) input parameters; more specifically, the inputs are determined by two (02) fuzzy membership functions.

(10 mark)

3.

a. Describe the key components of a typical fuzzy based inference system using a suitable diagram.

(4 mark)

b. The figure below (Fig.03) illustrates the fuzzification step of an interval valued type-2 fuzzy set. Interpret the terms of the expression $\mu_{Tall}(1.8) = [0.42, 0.78]$.

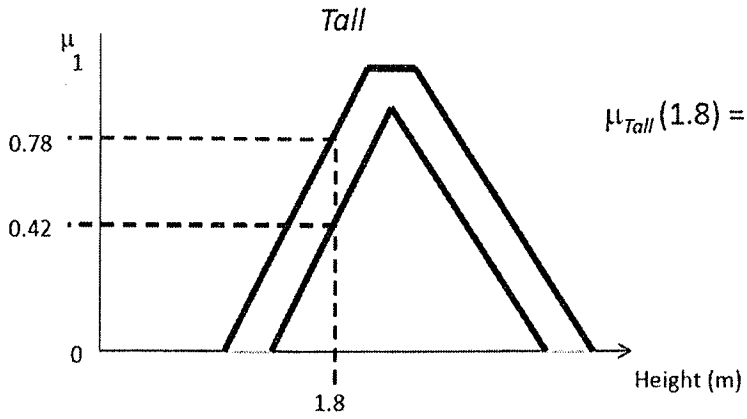

Figure 03: Fuzzification of an interval valued type-2 fuzzy set

(4 mark)

c. What is meant by defuzzification (in general)? Explain with an appropriate example.

(3 mark)

d.

i. Critically analyze the necessity of type-2 fuzzy sets in context of modeling uncertainty.

(6 mark)

ii. Develop a type-2 based inference system by extending the concepts associated with the components mentioned in part a. Re-design the block diagram developed in part a. by adding necessary new modules.

(8 mark)

4.

a. Discuss the importance of interval valued fuzzy membership functions with an appropriate example.

(5 mark)

b.

i. What are the commonly preferred fuzzy inference models?

(3 mark)

ii. Select one (01) of the fuzzy inference models listed above and explain how the inference is being performed using an appropriate example.

(5 mark)

c. Using a suitable diagram, briefly explain the principle of a typical closed-loop controller which rectifies the system error relying on a feedback mechanism.

(6 mark)

d. Propose a methodology to integrate fuzzy logic with the control theory in order to optimize a Proportional-Integral-Derivative (PID) controller.

(6 mark)