



**FACULTY OF ELECTRICAL & ELECTRONICS ENGINEERING
FINAL EXAMINATION**

COURSE	:	INTELLIGENT CONTROL
COURSE CODE	:	BEE4333
LECTURER	:	HASZURAI DAH ISHAK
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DURATION	:	3 HOURS
SESSION/SEMESTER	:	SESSION 2013/2014 SEMESTER II
PROGRAM CODE	:	BEE

INSTRUCTIONS TO CANDIDATES:

1. This question paper consists of **FOUR (4)** Questions. Answer **ALL** questions.
2. All answers to a new question should start on new page.
3. All the calculations and assumptions must be clearly stated.
4. Candidates are not allowed to bring any material other than those allowed by the invigilator into the examination room.

EXAMINATION REQUIREMENTS:

1. Graph paper

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

This examination paper consists of **EIGHT (8)** printed pages including front page

QUESTION 1

(a) Artificial Intelligence (AI) is the solution for any system that attempt to smartly decide and behave accordingly to a specific condition.

(i) Define what AI is.

[2 Marks]

(ii) Expert system has a number of rule types and one of it is known as strategic rules. List **TWO (2)** other types of the available rules in expert system.

[2 Marks]

(iii) To effectively organize an expert system, a development team must be assigned to carry their specific roles. List those role players and explain briefly their functions.

[10 Marks]

(b) There are various types of industrial robot that have been applied in industries such as articulated robot, scara robot, gantry and Cartesian robot. Each of those robots has their own specific and suitable task that others cannot perform well due to some aspects e.g time consuming, ease to apply etc. Among them, the articulated robot is the most popular used robot in manufacturing even though the robot is complex than the other robot types. The robot usually use it gripper to pick up things and perform several tasks.

(i) You have been appointed as person in-charge to classify products to be packaged. Those products have two shapes, one has round and the other one has cube shape. Apply the *strategy rule* to ensure the gripper can hold firmly those products.

(ii) Construct **TWO (2)** strategy rules for above problem.

(iii) In each rule in (ii), list **THREE (3)** conditions, and **ONE (1)** expected experience.

[11 Marks]

[CO1, PO1, C3]

QUESTION 2

- (a) Fuzzy logic is used often for computing the degree of truth of a specific problem. It is initially required for designer to understand the fuzzy set operation first before getting into the three stages in Fuzzy Logic. There are a number of fuzzy set operations and one of them is complement.
- (i) What does operation complement means?
- (ii) List **TWO (2)** other operations that are available.

[3 Marks]

- (b) Let X be the universe of military aircraft of interest, as defined here :

$$X = \{a10, b52, b117, c5, c130, f4, f14, f15, f16, f111, kc130\}$$

Let A be the fuzzy set of bomber class aircraft :

$$A = \left\{ \frac{0.2}{f16} + \frac{0.4}{f4} + \frac{0.5}{a10} + \frac{0.5}{f14} + \frac{0.6}{f15} + \frac{0.8}{f111} + \frac{1}{b117} + \frac{1}{b52} \right\}$$

Let B be the fuzzy set of fighter class aircraft :

$$B = \left\{ \frac{0.1}{b117} + \frac{0.3}{f111} + \frac{0.5}{f4} + \frac{0.6}{f15} + \frac{0.9}{f14} + \frac{1.0}{f16} \right\}$$

Find the following combinations for these two sets :

- | | |
|------------------------|---------------------------|
| (i) $A \cup B$ | (iv) $\bar{A} \cup B$ |
| (ii) $A \cap B$ | (v) $\overline{A \cap B}$ |
| (iii) $A \cup \bar{B}$ | (vi) $B A$ |

[6 Marks]

(c) A wheel type ground mobile robot has a capability to navigate autonomously. One of the crucial functions of an autonomous mobile robot is the capability to avoid collision. In order to avoid collision, autonomous mobile robot is necessarily to be completed with the function of braking system. Suppose we will apply the fuzzy expert system in the braking system of an autonomous mobile robot. The system has two inputs. The first input is the distance between the robot and object in front, D . And the second input is the velocity of the robot, v . The output of the system is the amount of braking that need to apply to the robot, B .

At one task, this robot is running at 35 km/h. Suddenly, it detects an object in front at the distance of 10 m.

- (i) Design by using Fuzzy Logic the fuzzy set membership for both inputs that consider the following rules,

IF the distance is short,
AND the velocity of the robot is medium,
THEN the amount of braking is high.

IF the distance is medium,
AND the velocity of the robot is medium
THEN the amount of braking is medium.

IF the distance is long,
THEN the amount of braking is low.

The fuzzy set to evaluate the amount of braking to be applied to the robot is given in Figure 1.

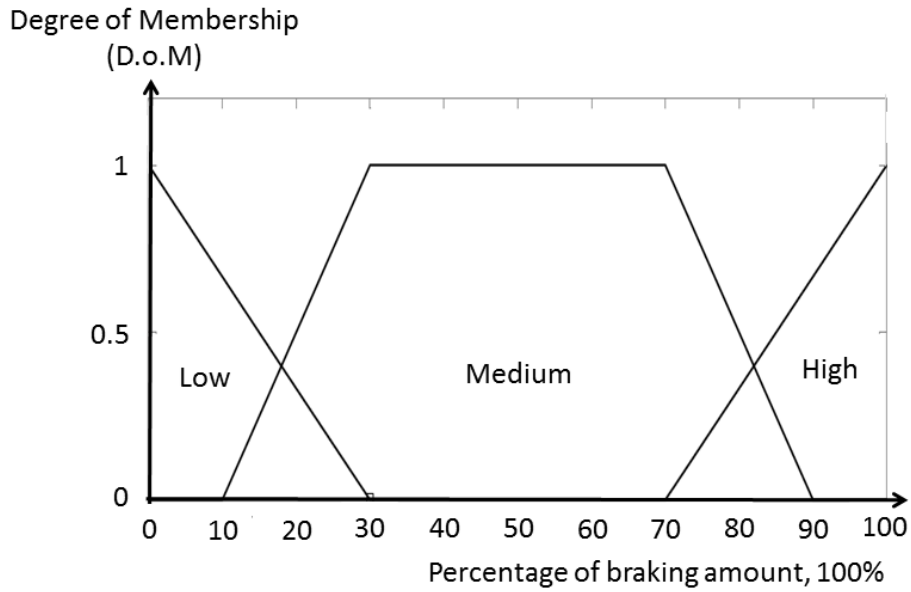


Figure 1 : Fuzzy set for braking system

The fuzzy membership must be design using the graph paper provided and satisfying the fuzzy sets describes in Figure 1. The fuzzy sets for input are given in Figure 2.

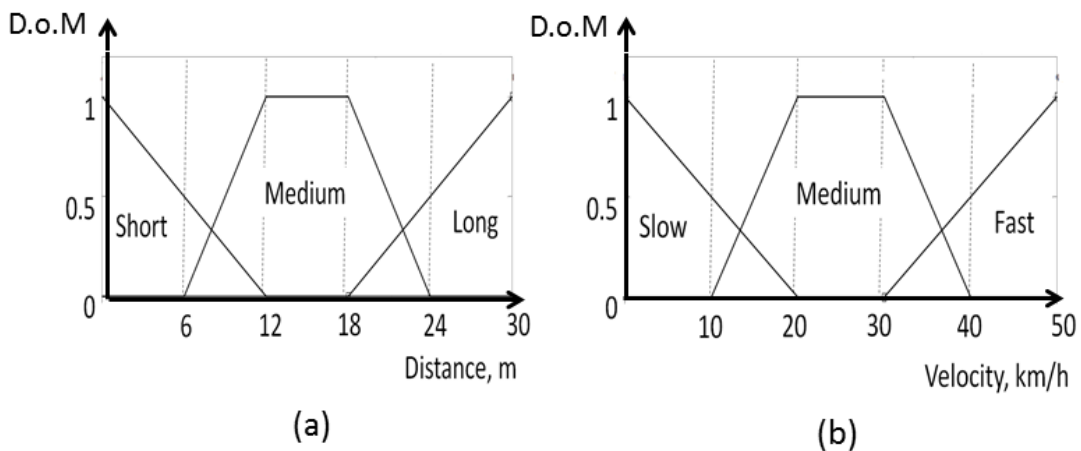


Figure 2 : Fuzzy sets for (a) distance and (b) velocity

- (ii) Using Mamdani – style inference, compute the degree of achievement (Center of Gravity) for the task above.

[16 Marks]
[CO2, P10, C4]

QUESTION 3

- (a) Machine learning is one of the most demanded criteria nowadays to support human in their daily life. One of the approach is Artificial Neural Network (ANN). Briefly explain the concept of Neural Network.

[2 Marks]

- (b) Perceptron is the simplest Artificial Neural Network developed in late 1950's by Frank Rosenblatt.

- (i) Illustrate the perceptron model

[3 Marks]

- (ii) For air conditioning system, define your own **THREE (3)** inputs and their associated weights between -0.5 to 0.5. Explain why you chose those inputs and their weights.

[4 Marks]

- (c) Figure 3 below illustrates a multilayer Neural Network that has the input patterns of (0 1 1).

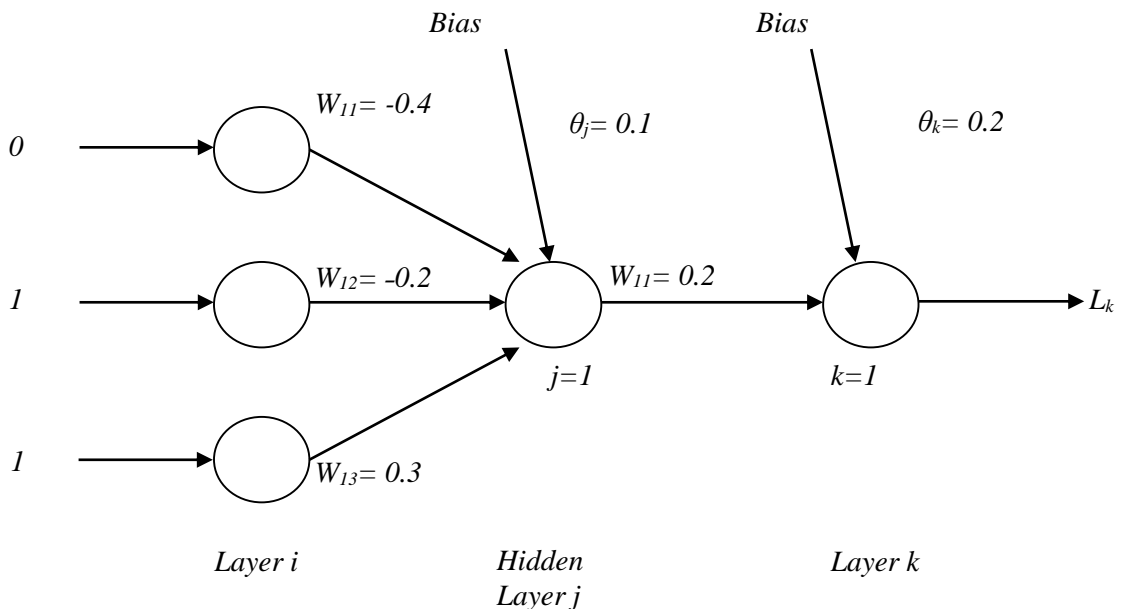


Figure 3: A Multilayer Neural Network

- (i) Calculate the output value of L_k .
- (ii) Given $t_k = 0$. From the value of L_k , calculate the following values at the first iteration by using Back Propagation algorithm.
- Δw_{11} and w_{11} (new) between output and hidden layer
 - Δw_{11} , Δw_{12} , Δw_{13} , and $w_{11}(\text{new})$, $w_{12}(\text{new})$, $w_{13}(\text{new})$ between hidden layer and input layer.
 - Illustrate the new Neural Network.

The information for the Neural Networks configurations are as follows.

Given $\eta = 0.4$ and $\alpha = 0.1$.

Back propagation is not required to be derived.

Sigmoid function; $f(x) = (1 + e^{-x})^{-1}$

$$f(x) = x$$

The error signals are as follows.

$$\delta_k = L_k (1 - L_k) (t_k - L_k)$$

$$\delta_j = L_j (1 - L_j) \sum_k \delta_k w_{kj}$$

Adaptions of weights are defined as below.

$$\Delta w_{kj}(t + 1) = \eta \delta_k L_j + \alpha \Delta w_{kj}(t)$$

$$\Delta w_{ji}(t + 1) = \eta \delta_j L_i + \alpha \Delta w_{ji}(t)$$

[16 Marks]
[CO2, P10, C4]

QUESTION 4

- (a) M. Negnevitsky defines Genetic Algorithm (GA) as a class of stochastic search algorithms based on biological evolution. There are **THREE (3)** simplest operators in GA; selection, crossover and mutation. Explain about these three operators.

[6 Marks]

- (b) Anti-Lock Braking System (ABS) is a system that helps vehicle to do emergency stop such as in a slippery conditions. There are four main components which are speed sensors, valve, pump and controllers. The speed sensor measures the vehicle speed and valve is used to provide sufficient pressure to the system. If pressure high, then vehicle stops immediately. Using GA, we can construct the system as follows.

- The chromosome can encode how ABS works. Consider only **TWO (2)** inputs to the system that is the vehicle speed and valve. The gene is shown by using a 4 bit binary string e.g 1101.
- Each **TWO (2)** of **FOUR (4)** different genes are representing the vehicle speed and valve respectively.
- The ideal chromosome (*High speed and medium pressure*) is **1101**.
- The current consumer population is shown in Table 1.

Table 1: Configurations

Type	Chromosome
1	0001
2	0010
3	0111
4	1011

- (i) Which type of the ABS system do you think will simulate the average current performance? Explain your answer.

[6 Marks]

- (ii) Calculate the fitness for above problem using GA approach by treating **ONE (1)** point for each gene that agrees with the ideal chromosome. Use the selection, crossover and mutation (if applicable) to find the best solution that similar to the ideal chromosome.

[13 Marks]
[CO3, PO3, C4]**END OF QUESTION PAPER**