

THE OPEN UNIVERSITY OF SRI LANKA  
FACULTY OF ENGINEERING TECHNOLOGY  
DEPARTMENT OF MECHANICAL ENGINEERING



027

**Study Programme: Bachelor of Technology Honours in Engineering**  
**Name of the Examination: Final Examination**  
**Course Code and Title: DMX5315 – Artificial Intelligence**  
**Academic Year: 2022/2023**  
**Date: 14th February 2024**  
**Time: 0930-1230 hrs.**  
**Duration: 3 hours**

#### **General Instructions**

- 1. Read all instructions carefully before answering the questions.**
- 2. This question paper consists of Five (5) questions.**
- 3. Answer ALL questions**
- 4. The total mark for the paper is 100.**
- 5. Answer for each question should commence from a new page.**
- 6. This is a CLOSED book test (CBT).**
- 7. Clearly state any assumptions that you may make.**
- 8. Answers should be in clear handwriting.**
- 9. Do not use red colour pen.**
- 10. This paper contains 05 pages including the cover page.**

### Question 1

Design a fuzzy control system for a washing machine with the specified input and output variables.

Inputs:

Water Level (liters):

VERY LOW: Triangle (0, 5, 10)

LOW: Triangle (5, 10, 20)

HIGH: Triangle (15, 20, 30)

VERY HIGH: Triangle (25, 30, 40)

Laundry Type:

DELICATE: Triangle (0, 1, 2)

NORMAL: Triangle (1, 2, 3)

HEAVY: Triangle (2, 3, 4)

VERY HEAVY: Triangle (3, 4, 5)

Output:

Wash Time (minutes):

VERY SHORT: Triangle (5, 10, 15)

SHORT: Triangle (10, 15, 20)

LONG: Triangle (15, 20, 30)

VERY LONG: Triangle (20, 30, 40)

a. Plot the membership functions for Water Level, Laundry Type, and Wash Time. (6 marks)

b. If only <sup>3</sup>two rules are assigned in the system as shown below, calculate the system output using the Mean of Maximum Height method at Water Level = 15 liters and Laundry Type = 2 (NORMAL). (14 marks)

Rule 1: IF Water Level is VERY LOW and Laundry Type is DELICATE, THEN Wash Time is VERY SHORT

Rule 2: IF Water Level is LOW and Laundry Type is NORMAL, THEN Wash Time is SHORT

Rule 3: IF Water Level is HIGH and Laundry Type is HEAVY, THEN Wash Time is LONG

## Question 2

A sample data set is given in Table Q2 (a) which consists of the data collected from a Lung Cancer Hospital. Answer the questions below by assuming that you have to train a Neural Network using the following data set in order to predict the risk of having lung cancer.

Table Q2(a): Sample Dataset

Age	Smoking History (years)	Exposure to Asbestos (yes/no)	Chronic Respiratory Issues (yes/no)	Family History of Cancer (yes/no)	Risk of Lung Cancer (%)
55	30	Yes	No	Yes	20
45	15	No	Yes	No	8
60	40	Yes	Yes	Yes	35
35	5	No	No	No	5
50	25	Yes	No	No	15
42	20	No	Yes	Yes	12
48	32	Yes	Yes	No	28
40	10	No	No	Yes	7
52	28	Yes	Yes	No	25
37	8	No	No	Yes	6
47	18	Yes	No	Yes	18

The data includes the following:

- Age represents the age of the individual.
- Smoking History is the number of years the person has been smoking.
- Exposure to Asbestos indicates whether the person has been exposed to asbestos (yes/no).
- Chronic Respiratory Issues indicates whether the person has chronic respiratory issues (yes/no).
- Family History of Cancer indicates whether there is a family history of cancer (yes/no).
- Risk of Lung Cancer is the target variable indicating the likelihood of developing lung cancer.

- a) State the type of the problem. **(5 marks)**
- b) What are the inputs and outputs of the Neural Network to be trained? **(5 marks)**
- c) What is the most suitable loss function that can be used for training the neural network? **(5 marks)**
- d) What is the best activation function that can be used for the output layer of the neural network to be trained and explain why you select it? **(5 marks)**

### Question 3

- a) State the features and the capabilities in which AI technology can be integrated in the following systems:
  - a. Self-Driving Cars (2 marks)
  - b. Autonomous Robots (2 marks)
  - c. Industrial Automation (2 marks)
  - d. Smart Manufacturing (2 marks)
  - e. Medical Robotics (2 marks)
- b) Explain the fundamental concept behind the Gradient Descent algorithm. How does it update model parameters during the optimization process? (4 marks)
- c) Describe the key concept of Conjugate Gradient (CG) optimization. In what scenarios is CG particularly advantageous over standard gradient descent methods? (4 marks)
- d) What distinguishes Quasi-Newton methods from other optimization techniques? Discuss the role of the Hessian matrix in these methods. (4 marks)
- e) Provide an overview of the Levenberg-Marquardt algorithm. (4 marks)
- f) Explain the significance of Stochastic Gradient Descent (SGD) in machine learning. How does it differ from traditional gradient descent, and what are its advantages in certain scenarios? (4 marks)

### Question 4

Implement a deep neural network (DNN) for sentiment analysis on a dataset of customer reviews. Each review is labeled as either positive or negative. The dataset consists of 10,000 reviews, with 80% for training and 20% for testing. The reviews are preprocessed and represented as numerical sequences.

- a) Design a deep neural network architecture for sentiment analysis. Specify the number of layers, types of layers (e.g., embedding, LSTM, fully connected), and activation functions you would use. Explain why you chose this architecture. (5 marks)
- b) Discuss the importance of weight initialization in training neural networks. Recommend a weight initialization technique, and explain how it helps in improving convergence during training. (5 marks)
- c) Explain the concept of backpropagation in the context of training a deep neural network. Discuss the role of optimization algorithms (e.g., Adam, SGD) and learning rate in the training process. (5 marks)
- d) After training your sentiment analysis model, propose two evaluation metrics to assess its performance on the test set. Explain why these metrics are suitable for sentiment analysis. (5 marks)

### Question 5

Assume that you are trying to recover a password to an encrypted file by using a search algorithm. You know that the password is up to 10 letters long and contains only the letters A, B, C.

Formulate a search problem using the following:

- The initial state is the empty string.
  - The successor function is to append one letter (A, B, or C) to the string.
  - The goal test is to verify a candidate password using the decryption software.
  - There are 6 correct passwords: AAACCC, ABBCC, BABAB, BCABACB, CBAC, and CBACB.
  - Assume that **all ties are broken alphabetically**. For example, if there is a tie between states “A”, “B”, and “C”, expand “A” first, then “B”, then “C”.
1. From the six correct passwords below, select the one that will be returned by **depth-first search: (Give appropriate justification to your choice of answer). (5 marks)**
    - a) AAACCC
    - b) ABBCC
    - c) BABAB
    - d) BCABACB
    - e) CBAC
    - f) CBACB
  
  2. From the six correct passwords below, select the one that will be returned by **breadth-first search: (Give appropriate justification to your choice of answer). (5 marks)**
    - a) AAACCC
    - b) ABBCC
    - c) BABAB
    - d) BCABACB
    - e) CBAC
    - f) CBACB

END OF THE PAPER