The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX7241-Neural Networks and Fuzzy Logic**
Academic Year	: 2021/22
Date	: 31^{sh} January 2023
Time	: 0930-1230hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **FOUR (4)** pages.
3. Answer **all questions.**
4. Answer for each question should commence from a new page.
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear hand writing and do not use red colour pen.

Question 1

(a) "A neural network cannot show the reasoning for a solution it is giving". Do you agree with this statement? Justify your answer. (3 marks)

(b) RNN and CNN network models represent two different concepts in learning. Compare and contrast their features. Give an example for each model where it can be best used. (8 marks)

(c) In each of the following cases, explain why Artificial Neural Networks (ANN) can be used for modeling the problem solution. Suggest the most suitable ANN to solve the problem and describe the relevance of the ANN which makes it most suitable.

(i) Recognition of fake emotions in an online interview
(ii) Predicting water quality in a future date
(iii) Pattern recognition in a foreign news feed (3x3 marks)

Question 2

(a) Considering supervised learning, name the two quantities that the error of a Backpropagation NN directly depends on. (2 marks)

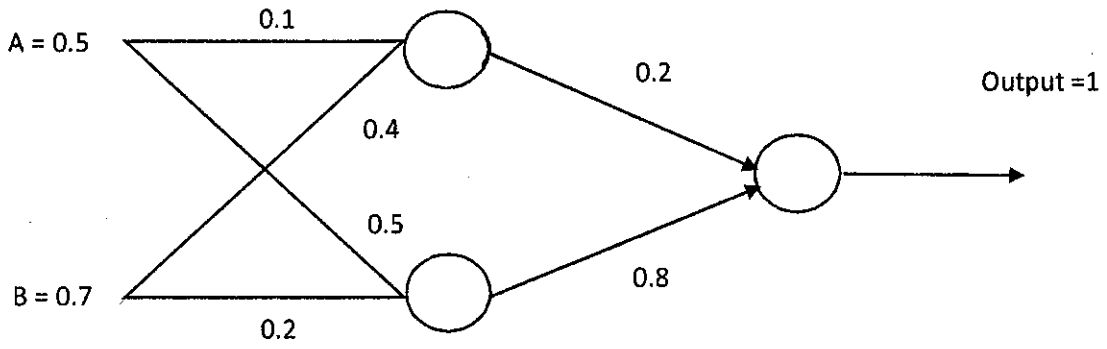
(b) How do you improve the training error (Sum error) of a Backpropagation neural network? (4 marks)

(c) Why is the **gradient descent algorithm** important in modeling ANNs? (2 marks)

(d) Assume that the neurons of the below ANN have Bipolar activation function and that $\alpha = 1$ and $\eta = 1$. Assume that the expected output is also set to 1.

i. Use Backpropagation training algorithm to find the error of the network after one traversal. (6 marks)

Use the following equation to calculate the error; ***Error = Output(1-output)(Target-output)***



ii. What will be the values of the new weights in the 2 branches of the hidden layer after the first iteration ? (6 marks)

Hint: $\Delta W = W_{new} - W_{old} = \eta \times (input)$

Question 3

An automatic watering plant designed for a cut flower farm uses a fuzzy logic controller for its control action considering the temperature and moisture of the soil. The watering plant controls the watering duration. The simple rule base used in the fuzzy controller for the water supply unit is as follows: -

R1: IF Temperature (T) is Hot AND Soil Moisture (SM) is Dry THEN Watering Duration (WD) is Long

R2: IF Temperature (T) is Warm OR Soil Moisture (SM) is Moist THEN Watering Duration (WD) is Medium

R3: IF Temperature (T) is Normal AND Soil Moisture (SM) is Wet THEN Watering Duration (WD) is Short

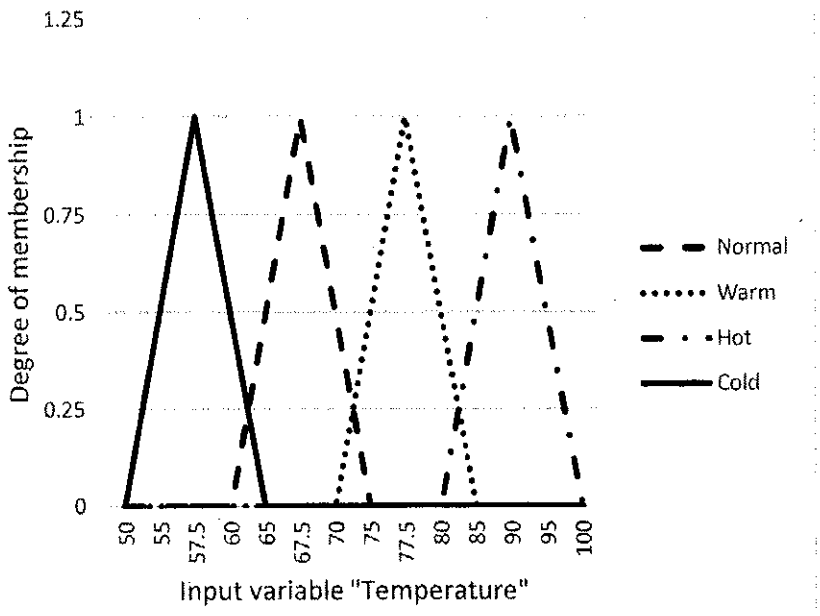
R4: IF Temperature (T) is Cold THEN Watering Duration (WD) is Long

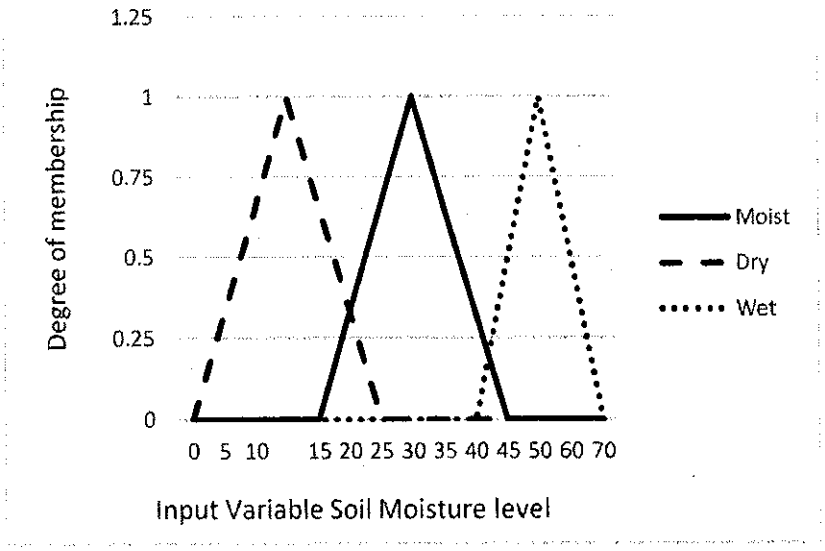
(a) List the Linguistic variables involved in this fuzzy system (3 marks)

(b) List the Linguistic values for each variable (8 marks)

(c) What is the fuzzy operator involved in this rule base? (3 marks)

(d) Consider the following fuzzy membership functions and answer the below questions: -





(e) Suppose the input values are temperature = 72.5 degrees and Soil Moisture Level = 42.5%. Find the fuzzy values for Watering Duration (WD) when the following rules are trigged:-

i. R1
ii. R2
iii. R4 (2*3 marks)

Question 4

(a) Given 2 fuzzy sets as,

$$A = \left\{\frac{0}{1}, \frac{0.7}{2}, \frac{0.4}{3}, \frac{0.6}{4}, \frac{0.1}{5}\right\}, \quad B = \left\{\frac{0}{1}, \frac{0.3}{2}, \frac{0.8}{3}, \frac{0.2}{4}, \frac{0.5}{5}\right\}$$

What is A∪B and $\bar{A}$/B ? (8 marks)

(b) Let R be a BFR (Binary Fuzzy Relation) on U × V and S be a BFR on V × W, where U= {a, b}, V={x, y} and W={&, *}. The max-min composition of R and S is BFR on U × W, denoted by S∘R.

$$R = \begin{matrix} 0.6 & 0.4 \\ 1.0 & 0.9 \end{matrix} \qquad S = \begin{matrix} 0.7 & 0.9 \\ 0.5 & 0.4 \end{matrix}$$

i. Write the formula to find the max-min composition of two fuzzy relations. (2 marks)
ii. Find the max-min composition of the given two fuzzy relations. (4 marks)

iii. Consider the ternary fuzzy relation T on $U \times V \times W$ is given by

$$T = \frac{0.2}{(a,x,\&)} + \frac{0.7}{(b,x,\&)} + \frac{0.3}{(a,y,\&)} + \frac{1}{(a,y,*)} + \frac{0.1}{(b,y,*)}$$

Find T1 , T2 , T3 and T13 (6 marks)

Question 5

Forecasting electricity demand in Sri Lanka is a widely discussed topic. Assuming that you are to devise an ANN to predict the electricity demand in Sri Lanka in 10 years' time answer the following questions.

(a) What will be the input parameters for any ANN model? (5 marks)

(b) If there are missing values for any input what methods can you use to fill the missing values? (2 marks)

(c) Identify a suitable Artificial Neural Network model to solve this problem and explain why you chose it? (4 marks)

(d) State the following for the neural network: (6 marks)

- No of nodes for input layer
- Number of Hidden layers
- Number of nodes for output layer

(e) If your ANN performs poorly on the validation set, list the possible causes why this would happen and suggest solutions to overcome the problem. (3 marks)