National Forensic Sciences University

School of Cyber Security and Digital Forensics

Course Name: M.Tech Artificial Intelligence and Data Science (Batch: 2024-26) Semester - II

Subject Code: CTMTAIDS SII P1 **Time: 03.30 pm to 05.00 pm**
Subject Name: Advanced Machine Learning for Cyber Security and Forensics
Exam: Mid Semester Examination (March - 2025) **Date: 20-03-2025**

Answer all questions.

Q1. Explain the role of activation functions in a neural network. Why is the ReLU function commonly used in deep networks instead of sigmoid? **6 marks**

Q2. Given a neural network with L layers, describe the forward propagation equations using the notation used in class. Clearly define the meaning of $W^{[l]}$, $b^{[l]}$, $Z^{[l]}$, and $A^{[l]}$.

6 marks

Q3. Consider a neural network with the following layer sizes: Input layer: 3 neurons, Hidden layer: 4 neurons, Output layer: 2 neurons

(a) How many weight parameters are in $W^{[1]}$ and $W^{[2]}$?

(b) How many bias parameters are in $b^{[1]}$ and $b^{[2]}$?

6 marks

Q4. Given the weight matrix:

$$W^{[1]} = \begin{bmatrix} 0.2 & -0.4 \\ 0.1 & 0.5 \end{bmatrix}$$

and bias vector:

$$b^{[1]} = \begin{bmatrix} 0.1 \\ -0.2 \end{bmatrix}$$

compute the pre-activation $Z^{[1]}$ if the input is:

$$X = \begin{bmatrix} 2 \\ 3 \end{bmatrix}.$$

6 marks

Q5. Explain the cost function for logistic regression and explain why the squared error cost function is not suitable for classification problems. **6 marks**

Q6. Consider an input image of size $32 \times 32 \times 3$. A convolutional layer uses 16 filters of size $5 \times 5 \times 3$, with a stride of 1 and padding of 2. Compute the output dimensions of this convolutional layer. **6 marks**

Q7. Explain the drawbacks of neural networks that are overcome by convolutional neural networks. **6 marks**

Q8. In a neural network, what does the weight matrix $W^{[l]}$ represent?

a) The input to layer l

b) The output of layer l

c) The parameters mapping activations from layer $l-1$ to layer l

d) The error at layer l **2 marks**

Q9. In a neural network with an input layer, one hidden layer, and an output layer, how many weight matrices are there?

a) 1

b) 2

c) 3 **2 marks**

d) $n+1$, where n is the number of hidden layers

Q10. What is the range of the sigmoid function used in logistic regression?

a) $(-\infty, \infty)$

b) $[0, 1]$

c) $(-1, 1)$ **2 marks**

d) None of the above

Q11. In logistic regression, what does the hypothesis function $h_\theta(x)$ represent?

a) The raw scores before applying activation

b) The probability that $y = 1$ given x

c) The gradient of the cost function

d) The decision boundary **2 marks**