# Daffodil International University

**Faculty of Science & Information Technology**

**Department of Computer Science & Engineering**

**Final Examination, Summer 2025**

**Course Code: CSE445, Course Title: Natural Language Processing**

**Level: 3 Term:3 Batch: 62**

**Time: 02:00 Hrs** **Marks: 40**

## Answer ALL Questions

*[The figures in the right margin indicate the full marks and corresponding course outcomes. All portions of each question must be answered sequentially.]*

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| **1.** | Explain the architecture and working principle of a Recurrent Neural Network (RNN). In your answer:<br>1. Describe how the hidden state is updated over time using the input vector, previous hidden state, and weight matrices (include the mathematical equations).<br>2. Explain the concept of vanishing and exploding gradients in RNNs and how they affect training.<br>3. Compare RNNs with LSTMs in terms of their ability to capture long-term dependencies. | **10** | **CO3** |
| **2.** | Define Large Language Models (LLMs) and explain their key characteristics. In your answer:<br>1. Describe what a *prompt* is and how it is used to interact with an LLM.<br>2. Discuss how prompt design can affect the quality and reliability of the model's output. | **5** | **CO5** |
| **3.** | Consider a simple feedforward neural network with:<br>• Input layer: 2 neurons ($x_1$,$x_2$)<br>• Hidden layer: 2 neurons with sigmoid activation<br>• Output layer: 1 neuron with sigmoid activation<br>• Loss function: Mean Squared Error (MSE)<br>Given:<br>• Inputs: $x_1$=0.05, $x_2$=0.10<br>• Target output: y=0.01<br>• Initial weights:<br>○ From input to hidden:<br>$w_{1,1}$=0.15, $w_{2,1}$=0.20(to hidden neuron h1)<br>$w_{1,2}$=0.25, $w_{2,2}$=0.30(to hidden neuron h2)<br>○ From hidden to output:<br>$w_{h1,o}$=0.40, $w_{h2,o}$=0.45<br>• Biases: $b_{h1}$=$b_{h2}$=0.35, bo=0.60<br>• Learning rate: η=0.5<br>After calculating MSE,you need to apply back propagation and adjust $w_{1,1}$ & $w_{1,2}$. | **15** | **CO3** |
| **4.** | A small dataset of short reviews about phones. We want to discover hidden topics such as **Hardware** (battery, camera, screen) and **Service/Price** (price, warranty, support). | **10** | **CO2** |

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|---|---|---|---|
| | Vocabulary V={battery, camera, screen, price, warranty, support}<br>Below each document is a short review (words repeated = token counts):<br>• d1: battery camera battery screen<br>• d2: camera screen camera battery<br>• d3: price warranty support price<br>• d4: price support warranty price<br>We choose the number of topics K=2 Use symmetric priors: $\alpha$=0.5 (document–topic), $\eta$=0.5(topic–word). Apply LDA for the above scenario. | | |