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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.]

1.	Explain the architecture and working principle of a Recurrent Neural Network (RNN). In your answer: 1. Describe how the hidden state is updated over time using the input vector, previous hidden state, and weight matrices (include the mathematical equations). 2. Explain the concept of vanishing and exploding gradients in RNNs and how they affect training. 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: 1. Describe what a *prompt* is and how it is used to interact with an LLM. 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: • Input layer: 2 neurons (x_1,x_2) • Hidden layer: 2 neurons with sigmoid activation • Output layer: 1 neuron with sigmoid activation • Loss function: Mean Squared Error (MSE) Given: • Inputs: x_1=0.05, x_2=0.10 • Target output: y=0.01 • Initial weights: ○ From input to hidden: $w_{1,1}$=0.15, $w_{2,1}$=0.20(to hidden neuron h1) $w_{1,2}$=0.25, $w_{2,2}$=0.30(to hidden neuron h2) ○ From hidden to output: $w_{h1,o}$=0.40, $w_{h2,o}$=0.45 • Biases: b_{h1}=b_{h2}=0.35, bo=0.60 • Learning rate: η=0.5 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} Below each document is a short review (words repeated = token counts): • d1: battery camera battery screen • d2: camera screen camera battery • d3: price warranty support price • d4: price support warranty price We choose the number of topics K=2 Use symmetric priors: α=0.5 (document–topic), η=0.5(topic–word). Apply LDA for the above scenario.		

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