Graphic Era HILL UNIVERSITY
Established by an Act of the State Legislature of Uttarakhand (Adhiniyam Sankhya 12 of 2011)
University under section 2(f) of UGC Act, 1956

End Term (EVEN) Semester Examination June 2025

Roll no.....

Name of the Course and Semester: B.Tech. CSE & VI
Name of the Paper: Advanced Machine learning
Paper Code: TCS 682

Maximum Marks: 100

Note:

(i) All the questions are compulsory.
(ii) Answer any two sub questions from a, b and c in each main question.
(iii) Total marks for each question is 20 (twenty).
(iv) Each sub-question carries 10 marks.

Q1. (2X10=20 Marks)

a. Critically analyze the trade-offs between bias and variance in high-dimensional data. How does regularization affect model complexity in this context? CO1

b. Given a dataset with mixed types (categorical and continuous), design a machine learning pipeline that includes preprocessing, model evaluation, and hyperparameter tuning. CO1

c. Discuss the implications of model interpretability in high-stakes ML applications. Propose methods to improve interpretability without sacrificing performance. CO1

Q2. (2X10=20 Marks)

a. Derive the backpropagation algorithm for a multi-layer neural network using sigmoid activations. What are the numerical issues involved? CO2

b. Explain vanishing and exploding gradient problems in RNNs and evaluate how architectures like LSTM and GRU address them. CO2

c. Design and explain a hybrid model that combines CNN and RNN for processing visual sequences (e.g., video captioning or gesture recognition). CO2

Q3. (2X10=20 Marks)

a. Compare the performance and architectural choices of object detection models: YOLOv5 vs. Faster R-CNN. Provide mathematical intuition for performance differences. CO3

b. Design an end-to-end image captioning system using CNN + RNN + Attention mechanism. Explain the role of each component and possible failure points. CO3

c. GANs are known to suffer from mode collapse. Explain this problem with examples, and critically evaluate methods like Wasserstein GAN that attempt to mitigate it. CO3

Q4. (2X10=20 Marks)

a. How does fine-tuning differ from feature extraction in transfer learning? Discuss scenarios where one is preferred over the other. CO4

b. Given a pre-trained DenseNet model, describe the steps to adapt it for a binary medical image classification task with a limited dataset. CO4

c. Implement a deep learning model using PyTorch for text classification using Doc2Vec embeddings. Justify your design choices at each step. CO4

Q5. (2X10=20 Marks)

a. Prove that Q-learning converges under certain conditions. What are the assumptions required, and what happens if they are violated?. CO5

b. Compare Policy Gradient methods with Value-based methods in terms of stability, convergence, and sample efficiency. CO5

c. Discuss the architecture and working of Deep Q-Network (DQN) and its improvements over traditional methods. CO5