Vellore Institute of Technology
(Deemed to be University under section 3 of the UGC Act, 1956)

Reg. No. : 22BAI1266

Final Assessment Test(FAT) - Nov/Dec 2024

Programme	**B.Tech.**	Semester	**Fall Semester 2024-25**
Course Code	**BCSE332L**	Faculty Name	**Prof. Rajalakshmi R**
Course Title	**Deep Learning**	Slot	**F1+TF1**
		Class Nbr	**CH2024250100978**
Time	**3 hours**	Max. Marks	**100**

General Instructions

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

Course Outcomes

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications
4. Design of test procedures to assess the efficiency of the developed model.
5. To understand the need for Reinforcement learning in real – time problems.

Section - I
Answer all Questions (7 × 10 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
01.	A development team at a tech company is working on creating a pet breed classification system. The goal of the project is to design a mobile application that allows users to upload pictures of their pets. The app will instantly identify the breed of the pet based on the uploaded image. Since the images come in different sizes, they are resized to 227x227 pixels with three colour channels (RGB) for uniform processing. The classification process involves the following steps using a Convolutional Neural Network (CNN): (i) First Convolutional Layer: A 3x3 filter with 96 filters (K = 96), no padding, and a stride of 1 is applied. (ii) Second Convolutional Layer: Another 3x3 filter with 256 filters (K = 256), no padding, and a stride of 1 is applied. (iii) Max Pooling Layer: A 2x2 max pooling operation with a stride of 2 is applied. (iv) Fully Connected Layer: A fully connected layer with 10 neurons is added at the end. (a) Calculate the output size and the number of feature maps at each layer. **[5 Marks]** (b) Calculate the total number of parameters to be learned in this setup. **[5 Marks]**	10	2	2
02.	Consider the grayscale image represented by the matrix below: The given grayscale image represented by the matrix below:	10	3,4	3

$$B = \begin{bmatrix} 2 & 4 & 1 & 3 & 2 \\ 5 & 3 & 6 & 1 & 8 \\ 3 & 7 & 2 & 0 & 3 \\ 4 & 0 & 5 & 4 & 1 \\ 2 & 3 & 4 & 2 & 4 \end{bmatrix}$$

The filters are defined as $F_1 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$; $F_2 = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$

(a). Perform the convolution operation on the image B using the kernel F_1 with padding 1 and a stride of 2. **(5marks)**

(b). Perform the convolution operation on the image B using the kernel F2 with padding 1 and a stride of 2. **(5 marks)**

03. You are working on a project to create realistic synthetic landscape images to expand a training dataset for an autonomous vehicle model, aiming to improve the model's performance in varied environmental conditions. 10 4 2

(a) Describe a system setup with two networks where one generates synthetic landscape images, and the other evaluates their realism. Explain how these networks interact during training to improve the quality of the generated images and any specific design choices you would make to enhance visual detail and variety in the landscapes. **(6 marks)**

(b) Identify common challenges in training this type of system, such as instability or lack of diversity in generated images. Describe the methods you would use to address these challenges, including your selection of loss functions, optimization techniques, and any additional training strategies to ensure stable learning and realistic outputs. **(4 marks)**

04. Imagine you are building a simple model to predict the score a student might get on a test based on four factors: Hours spent studying (input feature 1), Hours of sleep the night before (input feature 2), Number of practice tests taken (input feature 3), Attendance score (input feature 4). For three different students, you have the following input vectors: 10 2,3 3

- **Student 1**: X_1=[3,1,4,1]
- **Student 2**: X_2=[4,2,3,1]
- **Student 3**: X_3=[5,1,2,0]

The model includes a bias term b=1, representing the baseline score each student might get regardless of these factors.

The weights for each of these factors, learned through training, are:

W= [0.5, −0.5,0.25, −0.25]

There is no activation function at the output node. The expected outputs for each student are as follows:

- **Student 1**: Expected score = 3
- **Student 2**: Expected score = 4
- **Student 3**: Expected score = 2

(a) Total Loss Calculation **(8 Marks)**

i. Calculate the predicted score for each student using the provided weights, inputs, and bias term.

ii. Calculate the Mean Squared Error (MSE) for the predictions versus the expected outputs.

iii. Apply L1, L2, and Elastic Net regularization (with λ_1=0.1, λ_2=0.5) to compute the total loss for each regularization method.

(b) Discuss and Compare L1, L2, and Elastic Net Regularization Techniques **(2 Marks)**

Explain the differences among L1, L2, and Elastic Net regularization techniques, focusing on how they impact the model's weights and generalization.

05. As a software engineer working on a chatbot application for customer support, you are designing a system to understand and respond to user inquiries in natural language. The project requires using Recurrent Neural Networks (RNNs) to manage conversational flow and retain context. 10 3,4 2

(a) Describe the sequence-to-sequence (seq2seq) architecture you would use for this chatbot, detailing the roles of encoder and decoder RNNs. Explain how you would process user input and generate responses, including techniques such as attention mechanisms to maintain conversation context. **(6 marks)**
(b) Outline the training techniques and settings you would use for your chatbot, including the choice of loss function and optimization algorithm. Discuss how you would manage variable-length input sequences during training and why these techniques are essential for effective conversational responses. **(4 marks)**

06. You are a machine learning engineer at a fashion e-commerce company, tasked with enhancing customer experience through image processing. Your project involves two main goals: developing an Autoencoder for denoising user-uploaded images of clothing to improve visual quality and implementing a Variational Autoencoder (VAE) to generate new clothing designs based on existing styles. — 10 4 3
(a). Briefly describe the Autoencoder architecture you would use for image denoising and explain how you would compute the reconstruction loss. What metrics would you use to evaluate its performance? **(5 marks)**
(b). Highlight the key architectural differences between a VAE and a standard Autoencoder, focusing on the latent space and sampling process. Describe the components of the VAE loss function, emphasizing the importance of reconstruction loss and Kullback-Leibler divergence. **(5 marks)**

07. You are a data scientist working on a project to develop an intelligent agent for a smart warehouse management system. The agent is tasked with navigating through the warehouse to optimize the picking process. The warehouse layout is a grid environment, where the agent must pick items from various shelves while avoiding obstacles and minimizing travel time. The agent receives rewards for picking items and penalties for hitting obstacles. Apply Q-learning techniques, explain how you would train the intelligent agent to optimize its picking strategy in the warehouse. In your response, cover the following aspects: — 10 5 2
(a)Describe how you would represent the state space for the agent in the warehouse environment. Explain your strategy for action selection, including the exploration-exploitation trade-off. **(6 marks)**
(b)Outline the Q-value update process, including the role of the learning rate and discount factor in refining the agent's policy. **(4 marks)**

Section - II
Answer all Questions (2 × 15 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
08.	(i)You are a data scientist working for a retail store chain. The company aims to implement a real-time system that monitors customer behavior and optimizes store layout. This system should be capable of detecting and tracking customers across different zones of the store (such as checkout areas and product displays) and analyzing their time spent in each zone. (a)Why is the YOLO (You Only Look Once) algorithm a suitable choice for this application compared to traditional object tracking methods? Outline the steps involved in training a YOLO model for customer detection and zone tracking in retail stores. **(5 marks)** (b)Consider a hypothetical YOLO-X object detector that uses a 32x32 grid and can detect 6 object classes. If YOLO-X uses 6 anchor boxes per grid, what will be the output volume dimensions when this variant of YOLO is applied to an image of size 1024x1024? **(5 marks)** (ii) An image containing a cat is processed by the YOLO algorithm. The ground truth bounding box for the cat is 100 pixels wide and 50 pixels high. YOLO predicts a bounding box that is 80 pixels wide and 40 pixels high. There is a 20-pixel horizontal overlap and a 10-pixel vertical overlap between the two boxes. Calculate the Intersection over Union (IoU) between the predicted bounding box and the ground truth bounding box. **(5 marks)**	15	2,3	5

09. 15 1,2 3

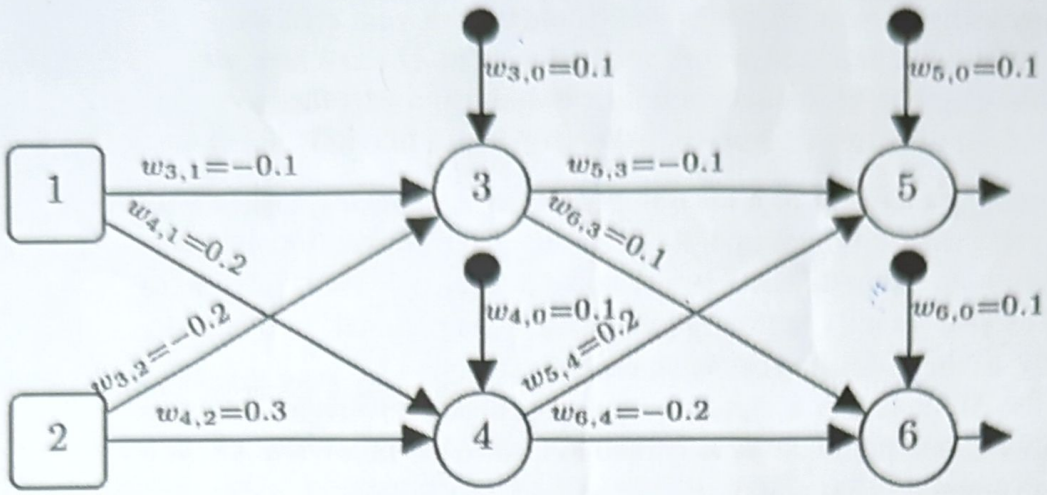

Figure.1: Neural Network architecture

Given the feed forward neural network in Figure 1, assume the following:

- Input Neurons: Neuron 1 = 0.3 and Neuron 2 = 0.6
- Desired Output: Neuron 5 = 0.7 and Neuron 6 = 0.4
- Activation Function: Logistic (sigmoid) activation function for all processing neurons.

(a) Forward Propagation and Error Calculation **[6 Marks]**

- Perform forward propagation to calculate the output values of Neurons 5 and 6.
- Calculate the total error using Mean Squared Error (MSE) based on the desired outputs.

(b) Backpropagation for Targeted Weights **[9 Marks]**

- Perform backpropagation to compute the gradients only for the following weights:
  - w3,1 (the weight from Neuron 1 to Neuron 3)
  - w5,3 (the weight from Neuron 3 to Neuron 5)
- Using a learning rate of 0.1, show the updated values of these two weights after one backpropagation step.

BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)

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