DEEP LEARNING
(CSEN 4142)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

    Choose the correct alternative for the following

    (i)   The process of adjusting the weights and biases of a network is known as
          (a) Activation   (b) Synchronisation
          (c) Learning   (d) None of the above.

    (ii) What is the input value range for Rosenblatt's perceptron?
          (a) (0,1)   (b) [0,1]   (c) {0,1}   (d) (0,1].

    (iii) What is the role of gradient descent in deep convolutional neural network?
          (a) To minimize the loss function
          (b) To find the optimal weights for the neural network
          (c) To update the network's parameters
          (d) All of the above.

    (iv) What is the purpose of a recurrent neural network?
          (a) To deal with sequential data   (b) To classify images
          (c) To perform dimensionality reduction   (d) To generate synthetic data.

    (v)   What is the purpose of a convolutional layer in a convolutional neural network?
          (a) To reduce the dimensionality of the input
          (b) To extract spatial local features from the input
          (c) To classify the input data
          (d) To apply non-linear transformations to the input.

    (vi) Which deep learning technique is used for generating new and realistic data samples?
          (a) Convolutional neural network   (b) Reinforcement learning
          (c) Generative adversarial network   (d) Transfer learning.

    (vii) What is a generative model in deep learning?
          (a) A model that generates random data for testing
          (b) A model that uses unsupervised learning to learn patterns in the data
          (c) A model that generates new data samples that resemble the training data
          (d) A model that generates random weights for initializing neural networks.

(viii) Which deep model architecture is used for reinforcement learning tasks?
(a) Convolutional neural networks   (b) Recurrent neural networks
(c) Autoencoders   (d) Deep Q-Networks.

(ix)   What does the term "preprocessing" refer to in the context of image captioning?
(a) Adjusting the learning rate during training
(b) Pre-training the neural network using unsupervised learning
(c) Preparing and transforming the raw data before feeding it into the model
(d) Fine-tuning a pre-trained model on a new task.

(x)   What is an agent in reinforcement learning?
(a) Agent is the situation in which rewards are being exchanged
(b) Agent is the simple value in reinforcement learning
(c) An agent is an entity that explores the environment
(d) None of the above.

Fill in the blanks with the correct word

(xi)   Boltzmann machine is an _____ based model.

(xii)   Hebbian learning rule was developed for _____ learning.

(xiii) Random and probabilistic events are also known as _____ events.

(xiv)   VGGNet is an example of _____ neural network.

(xv)   The minimum number of hidden nodes in a radial basis function network is given by _____ theorem.

Group - B

2. (a) Discuss the effect of learning rate on the learning of single layer perceptron using back-propagation algorithm.   *[(CO1)(Understand/LOCQ)]*
    (b) Describe what is likely to happen when a learning rate is used that is too large, and when one is used that is too small. How can one optimize the learning rate?
                                                                                [(CO1)(Apply/IOCQ)]
    (c) Describe the importance of using bias in neural network.   *[(CO1)(Understand/LOCQ)]*
    (d) Explain the main reasons why a back-propagation training algorithm might not find a set of weights which minimizes the training error for a given feed-forward neural network.   *[(CO1)(Apply/IOCQ)]*
    (e) Explain the purpose of the momentum term that is often included in the back-propagation learning algorithm.   *[(CO1)(Apply/IOCQ)]*
                                                                        2 + 3 + 2 + 3 + 2 = 12

3. (a) State the Cover's theorem on separability of patterns.   *[(CO3)(Remember/LOCQ)]*
    (b) How many layers a radial basis function network can have? Identify the layers in radial basis function network which perform linear and the layers which perform non-linear transformations.   *[(CO3)(Apply/IOCQ)]*
    (c) Define the receptors of radial basis function network. What is the dimension of each of the receptors? State and justify the minimum number of receptors in the radial basis function network.   *[(CO3)(Understand/LOCQ)]*

(d) Describe the primary differences between radial basis function network and multi-layer perceptron. *[(CO3)(Apply/IOCQ)]*

2 + (1 + 2) + (1 + 1 + 2) + 3 = 12

Group - C

4. (a) Given the input matrix and the kernel, perform convolution with stride being 1.

1	0	1	1	0
0	0	0	1	1
1	0	0	0	1
0	1	1	1	0
1	1	0	1	0

Input Matrix

1	0	0
0	0	1
1	1	0

Kernel Matrix

[(CO3)(Apply/IOCQ)]

(b) Apply max-pooling and sum-pooling on the results from the above convolutions. *[(CO3)(Apply/IOCQ)]*

4 + (4 + 4) = 12

5. (a) Explain with example what is spatial data? How spatial features can be extracted from an input data. *[(CO4)(Understand/LOCQ)]*

(b) Discuss the concept of transfer learning in deep neural networks and explain how it can be used to improve the performance of a convolutional neural network for image classification tasks. *[(CO4)(Apply/IOCQ)]*

(c) What is the main difference between a convolutional neural network and a recurrent neural network? *[(CO4)(Understand/LOCQ)]*

4 + 4 + 4 = 12

Group - D

6. (a) Discuss the architecture and working principle of deep Boltzmann machine. *[(CO4)(Understand/LOCQ)]*

(b) Explain how deep Boltzmann machine is different from deep belief network in terms of both architecture and learning algorithm. *[(CO4)(Apply/IOCQ)]*

(4 + 4) + 4 = 12

7. (a) What is the working principle of variational autoencoders and how they are used in generative modelling? *[(CO4)(Analyse/HOCQ)]*

(b) Mention the approaches used to estimate the data-dependent expectation and data-independent expectation in deep Boltzmann machines. *[(CO4)(Remember/LOCQ)]*

(c) Explain greedy layerwise pre-training in context of deep variational autoencoders. *[(CO4)(Apply/IOCQ)]*

4 + 4 + 4 = 12

Group - E

8. (a) What is image segmentation? How it is used in computer vision applications? *[(CO6)(Analyse/HOCQ)]*

(b)   Explain the differences between image segmentation and object detection.

[(CO6)(Apply/IOCQ)]

(4 + 4) + 4 = 12

9. (a)   Explain Q-Learning.   *[(CO5)(Analyse/HOCQ)]*
    (b)   Explain the differences between the positive and negative reinforcement learning.   *[(CO5)(Apply/IOCQ)]*
    (c)   State and explain the steps involved in reinforcement learning algorithm.

[(CO5)(Understand/LOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.42	47.91	16.67