

**M.E. Computer Science and Engineering - First Year - Second Semester Examination 2025****Subject:** Deep Learning and Applications**Time:** Three hours**Full marks:** 100*Answer any five questions*

1.
  - a. Why is deep learning preferred over traditional machine learning approaches in modern applications? 3
  - b. Discuss the vanishing and exploding gradient problems in deep networks and mention two methods to address them. 7
  - c. Explain the role of the convolutional layer in a CNN. 5
  - d. What are the roles of hidden layers in a multilayer neural network? 5
  
2.
  - a. Explain how the representational capacity of encoder and decoder affects the learning in autoencoders. 5
  - b. What is an undercomplete autoencoder and how does it relate to PCA? 5
  - c. What is the role of regularization in autoencoders ? 10  
Briefly describe any three types of regularized autoencoders.
  
3.
  - a. How does the Variational Autoencoders (VAEs) use the latent space during inference and generation? Explain with appropriate example. 7
  - b. What is the Evidence Lower Bound (ELBO) in the context of VAEs? 5
  - c. What is the reparameterization trick in VAEs? Explain briefly. 8
  
4.
  - a. Explain the concept of representation learning in the context of Transfer Learning. Why are early CNN layers considered more general? 7
  - b. Describe the fine-tuning process in Transfer Learning. Why is it important to freeze certain layers initially and use differential learning rates? 8
  - c. What are the advantages of using 1x1 convolution layers in deep neural networks? Explain with reference to computational and memory benefits. 5
  
5.
  - a. Calculate the output volume size for a convolutional layer with a 128x128x3 input, 15 filters of size 5x5, stride 2, and padding 2. Show all steps. 8
  - b. What is the purpose of pooling layers in CNNs? Explain with an example how max pooling works and its effect on the feature map. 7
  - c. Compare and contrast the following optimization algorithms: AdaGrad and Adam. 5
  
6.
  - a. Compare and contrast hard constraint and soft constraint views of regularization. Provide suitable optimization formulations for each. 7

[ Turn over

- b. What is early stopping in neural network training? Explain how it functions as a regularization method, along with its pros and cons. 8
- c. Explain the role of noise in regularization. How does adding noise to inputs or weights relate to weight decay? 5
7. a. Why is CNN not suitable for sequential data handling? 4
- b. Describe different types of RNN. 4
- c. What are the main difficulties when training RNN? How can you handle the difficulties? 6
- d. What are the key component of LSTM. Describe the utility of each component 6
8. a. Explain the principle of Maximum Likelihood Estimation (MLE) and the reasoning behind using MLE to estimate  $\theta$ . 5
- b. i. Perform a 2D convolution on the following input using the given kernel, stride = 2 and no padding. 5+5  
+5

1	0
-1	1

Filter/Kernel:

1	2	0	1	3	3
4	1	1	0	2	2
2	3	2	1	0	0
1	0	1	3	2	2
2	1	0	1	1	1
3	2	1	4	1	1

Input Matrix :

- (ii) On the above obtained matrix from part (i), apply ReLU activation function.
- (iii) Which regularization method leads to weight sparsity? Explain why?