Class Test on Convolutional Neural Networks (CNN)

Total Marks: 20
Time: 40 Minutes

Answer the following questions briefly and clearly.

1. **What is a Convolutional Neural Network (CNN)? Why is it mainly used?**
   A CNN is a deep learning model designed to process visual data such as images or videos. It automatically detects features like edges, corners, and textures without manual feature extraction. *Example:* CNNs are used in systems like facial recognition on smartphones. (1)

2. **Why is the convolution process necessary in CNN?**
   The convolution operation helps extract important local features (like edges or shapes) from an image while reducing the number of parameters. *Example:* A small filter sliding over a cat image detects patterns such as the cat's eyes or ears. (1)

3. **What is the main difference between CNN and a fully connected network?**
   In CNN, each neuron connects only to nearby pixels, while in a fully connected network, every neuron connects to all neurons in the previous layer. This makes CNN more efficient and better for image data. (1)

4. **What is the purpose of using filters (kernels) in CNN?**
   Filters help identify key visual features by scanning the image region by region. *Example:* A vertical edge filter highlights vertical lines in the image. (1)

5. **Define "feature extraction" in CNN.**
   Feature extraction means finding important information from images that represent patterns like edges, colors, or shapes. *Example:* The first CNN layer detects edges; deeper layers detect more complex objects like faces. (1)

6. **What is padding? Why is it used in CNN?**
   Padding adds zeros around the image border so that important edge information is not lost and output size remains the same. *Example:* A 3×3 filter on a 5×5 image becomes 5×5 again with padding. (1)

7. **Explain stride and its effect on the output size.**
   Stride defines how many pixels the filter moves each time. A higher stride reduces output size, while a smaller stride gives more detail. *Example:* Stride 1 gives detailed results, stride 2 skips pixels and reduces image size. (1)

8. **What is pooling? Differentiate between Max Pooling and Average Pooling.**
   Pooling reduces the feature map size and keeps the most important values, helping to make the model faster and avoid overfitting. - **Max Pooling:** Takes the largest value from each region. - **Average Pooling:** Takes the average of values in each region. *Example:* In a 2×2 region $[1, 3, 2, 4]$, Max Pooling gives 4, Average Pooling gives 2.5. (2)

9. **What is the purpose of the activation function (ReLU) in CNN?**
ReLU (Rectified Linear Unit) introduces non-linearity so CNN can learn complex relationships. It replaces negative values with zero: $f(x) = \max(0, x)$. (1)

10. **Name the main layers used in CNN architecture.**
Common layers are: Convolution Layer, Pooling Layer, Flatten Layer, Fully Connected Layer, and Output Layer. (1)

11. **What is flattening and why is it required before the fully connected layer?**
Flattening converts 2D feature maps into a 1D vector so that they can be passed into the fully connected layer for classification. (1)

12. **What is the function of the fully connected layer?**
The fully connected layer takes all extracted features and combines them to predict the final output. *Example:* It decides whether an image is of a cat or a dog. (1)

13. **Explain the concept of weight sharing in CNN.**
Weight sharing means using the same filter (same weights) across the entire image, which reduces parameters and speeds up training. *Example:* One edge-detecting filter can detect edges anywhere in the image. (2)

14. **How does CNN handle large image inputs efficiently?**
CNN handles large images using convolution and pooling layers that gradually reduce image size while preserving key information. (1)

15. **Mention two real-life applications of CNN.**
1. Facial recognition in smartphones. 2. Medical imaging for detecting diseases. (1)

16. **How does CNN achieve translation invariance?**
CNN achieves it because filters detect features regardless of their position in the image. *Example:* A cat can be recognized even if it appears in a different corner of the picture. (1)

17. **What is overfitting and how can it be reduced?**
Overfitting occurs when the model memorizes training data but fails on new data. It can be reduced by using dropout layers, data augmentation, or regularization. (1)

18. **What are pre-trained CNN models? Give one example.**
These are CNNs already trained on large datasets and can be reused for new tasks. *Example:* VGG16, ResNet, or AlexNet. (1)

19. **Why do we use dropout layers in CNN?**
Dropout randomly turns off some neurons during training to prevent overfitting and improve generalization. (1)

20. **How can data augmentation improve CNN performance?**
Data augmentation increases training data by rotating, flipping, or zooming images, helping the CNN learn better and become more robust. (1)

Total Marks: 20

Best of Luck!