

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)**

CLASS: BTech
BRANCH: AIML

SEMESTER : VII
SESSION : MO/2025

SUBJECT: AI425 COMPUTER VISION

TIME: 3 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
 2. Attempt all questions.
 3. The missing data, if any, may be assumed suitably.
 4. Before attempting the question paper, be sure that you have got the correct question paper.
 5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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|--|-----|-----|
| Q.1(a) Given the sequence
$x[n] = [1, 2, 3, 4], n = 0,1,2,3$
Compute the 4-point DFT $F(k)$, for $k=0,1,2,3$ and verify the inverse DFT recovers $x[n]$. | [5] | 1 2 |
| Q.1(b) Given the 3X 3 grayscale image patch:
$I = \begin{bmatrix} 10 & 10 & 10 \\ 10 & 50 & 10 \\ 10 & 10 & 10 \end{bmatrix}$
Compute the Laplacian response at the center pixel. | [5] | 1 2 |
| Q.2(a) For a particular pixel in an image, the structure tensor (second-moment matrix) is computed as:
$M = \begin{bmatrix} 200 & 10 \\ 10 & 5 \end{bmatrix}$
(i) Compute the eigenvalues λ_1 and λ_2 of the matrix M .
(ii) Using the eigenvalue interpretation of the Harris detector, classify the pixel as a flat region, edge, or corner. | [5] | 2 4 |
| Q.2(b) Consider the following 4x4 grayscale image patch (row and column indices are 1-based):
$I = \begin{bmatrix} 3 & 5 & 2 & 1 \\ 6 & 7 & 5 & 2 \\ 4 & 6 & 8 & 3 \\ 1 & 2 & 3 & 4 \end{bmatrix}$
Compute the integral image I_2 | [5] | 2 2 |
| Q.3(a) The 4x4 block of DCT coefficients and the 4x4 portion of the JPEG quantization matrix is given as: is given as:
$C = \begin{bmatrix} 400 & 30 & 20 & 10 \\ 15 & 5 & -2 & -1 \\ 4 & 3 & -1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \quad Q = \begin{bmatrix} 16 & 11 & 10 & 16 \\ 12 & 12 & 14 & 19 \\ 14 & 13 & 16 & 24 \\ 14 & 17 & 22 & 29 \end{bmatrix}$
Quantize the DCT coefficients and produce the zig-zag ordering of the quantized coefficients | [5] | 3 3 |
| Q.3(b) A 2-D point P (8,4) is to be rotated by 45° counterclockwise about the line passing through points A= (2,1) and B= (6,3). Compute the new coordinates of point P after rotation about the axis AB. | [5] | 3 2 |
| Q.4(a) How is the idea of max pooling similar to the way the human visual system processes information? | [5] | 4 2 |

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Q.4(b) You are given the following 4×4 image patch: [5] 4 4

$$I = \begin{bmatrix} 1 & 2 & 1 & 0 \\ 0 & 1 & 3 & 2 \\ 2 & 1 & 0 & 1 \\ 1 & 2 & 1 & 3 \end{bmatrix}$$

and a 2×2 filter (kernel):

$$K = \begin{bmatrix} 1 & 0 \\ -1 & 1 \end{bmatrix}$$

Assume stride = 1 and no padding. Perform 2D convolution (valid convolution) of the filter K on the image I and write the 3×3 output feature map.

Q.5(a) A YOLO detector predicts three bounding boxes for the same class “person” in an image: [5] 5 4

Box Confidence

B1 0.92

B2 0.87

B3 0.81

Assume the IoU between B1 & B2 is 0.78, IoU between B1 & B3 is 0.00, and IoU between B2 & B3 is 0.00.

Using the IoU values given, identify which boxes will be suppressed using Non-Maximum Suppression (NMS) and which box will remain as the final detection.

Q.5(b) In a diffusion model, noisy images are gradually formed by adding small amounts of [5] 5 3

Gaussian noise at each step. Explain what the reverse diffusion process does, and how it allows the model to generate a clean image starting from pure noise.

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