MM: 90 (30%)                              9th October 2023                              Time: 90 minutes

(i) Attempt all parts of a question consecutively.

(ii) Full credit will only be given if the Solution is neat, and showing all the required steps.

**Q1.**  Short answer

**a)** When do spatial correlation and convolution yield the same result? show with example.

**b)** An 8x8, 8-bit image's histogram is uniformly distributed. The image is enhanced by histogram equalization method. Draw the histogram of processed image and comments on result.

**c)** Find the 0th bit-plane and 15th bit-plane of the following 4-bit image. Which one is having more information?

| 0 | 3 | 7 | 8 |
|---|---|---|---|
| 1 | 1 | 2 | 2 |
| 3 | 14 | 15 | 13 |
| 4 | 6 | 9 | 11 |

d) Find the DFT coefficient for u = 2, v = 2 and u = 0, v = 0 for given image. (Top left pixel is (0,0))

| 1 | -1 | 1 | -1 |
|---|---|---|---|
| -1 | 1 | -1 | 1 |
| 1 | -1 | 1 | -1 |
| -1 | 1 | -1 | 1 |

**[4x5]**

**Q2.**  One way to perform linear interpolation is first interlacing zeros along rows and columns in the original data and then convolving with interpolating window. For the following data u, and the interpolation window H, show the result of linear interpolation.

Image patch $u = \begin{vmatrix} 2 & 1 \\ 4 & 5 \end{vmatrix}$ and the interpolating window $H = \frac{1}{4}\begin{vmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{vmatrix}$

Show-   a) Zero interlaced matrix u' with the size 4 x 4. (interlace zeros next to row / column)

b) Result of  $y = u' \otimes H$, y has the size 6 x 6. ($\otimes$ - convolution operation)

c) The resulting data of the interpolation, which has the size 4 x 4.

Assume zero padding if it required.                              **[4+12+4]**

**Q3.**  **a)** Prove that the Fourier kernel is separable.

**b)** Suppose that the image undergoes uniform linear motion in the x-direction and y-direction at a

rate $x_0(t) = at/T$ and $y_0(t) = 0$. Show that the degradation Function $H(u,v) = \dfrac{T}{\pi ua}\sin(\pi ua)e^{-j\pi ua}$

**[2x10]**

**Q4.**   **a)** Find the Huffman code of following Image. Is the Huffman code an instantaneous code? Justify your answer.

| 26 | 26 | 36 | 26 |
|----|----|----|----|
| 26 | 26 | 36 | 26 |
| 210 | 250 | 210 | 250 |
| 210 | 250 | 210 | 250 |

**b)** Find the LZW code of following 4x4 image by left-to-right, top-to-bottom manner. The size of dictionary is 9-bits. Determine the efficiency of the LZW code and comments.

| 26 | 26 | 26 | 26 |
|----|----|----|----|
| 26 | 26 | 26 | 26 |
| 250 | 250 | 250 | 250 |
| 250 | 250 | 250 | 250 |

**[2x15]**