Ref No: **Ex/PG/ELE/PE/T/114D/2025**

M. E. ELECTRICAL ENGG. FIRST YEAR 1ST SEMESTER EXAM, 2025

MASTER IN ILLUMINATION ENGG. FIRST YEAR 1ST SEMESTER EXAM, 2025

SUBJECT: - DIGITAL IMAGE PROCESSING

Time: Three hours | Full Marks 100

No. of Questions	PART I	Marks
	Answer ALL questions.	
1. (a)	A 5×5 image is given in Fig. 1(a) where $I(i,j)$ gives the pixel intensity at ith row and jth column position. This image is high pass-filtered using the mask given in Fig. 1(b). Determine the output filtered pixel intensity values at (3,3) and (4,2) positions, where original intensity values are 35 and 56, respectively.	08

172	25	93	59	11
21	34	232	63	251
203	12	35	44	116
224	56	132	47	98
151	31	121	51	162

Fig. 1(a)

1	-2	1
-2	5	-2
1	-2	1

Fig. 1(b)

(b)	How can image sharpening be carried out using Laplacian? Hence how can four types of Laplacian masks be developed? How these masks can be modified to perform sharpening yet preserve original background features?	08
	OR	
(b)	What is the illumination-reflectance model in image processing? How can homomorphic filters be developed using this model? Why does high frequency emphasis filtering require a post-filtering processing? (CO1-K1,K2)	08
2.	Answer ***ANY TWO*** questions: (CO3-K3)	
(a)	(*i*) With a suitable example, demonstrate how edge strength and direction at a point can be obtained using image gradient.	05
	(*ii*) What are the constraints of edge detection algorithms? How can a simplified procedure of local processing be employed to overcome these problems for real time applications?	06
	(*iii*) Differentiate between global thresholding, local thresholding and variable thresholding procedures employed for image segmentation. How can an iterative algorithm be	06

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	employed to perform global thresholding? How can you control the number of iterations performed by this algorithm?	
2. (b)	(*i*) In affine transform based image registration, what will be the corresponding pixel coordinates in the transformed image when the pixel coordinates in the original image are (78,46) and (121,36). In each case consider two different affine transformation matrices given in Fig. 2(a) and Fig. 2(b) respectively.	07

0.8	0	0
0	1.9	0
0	0	1

Fig. 2(a)

cos45°	sin45°	0
-sin45°	cos45°	0
0	0	1

Fig. 2(b)

	(*ii*) Describe both the spatial domain and frequency domain representations of a model used for image degradation/restoration process. What are the probability density functions used to model Rayleigh noise and Erlang noise? What are the expressions for mean and variance for these two density functions?	05
	(*iii*) How can geometric mean filter and harmonic mean filter be employed for image restoration? What are the strengths and weaknesses of these two methods?	05
(c)	(*i*) In the context of image compression, differentiate between coding redundancy, spatial and temporal redundancy, and irrelevant information. How is relative data redundancy related to compression ratio? Why are variable-length codes preferred over fixed-length codes?	06
	(*ii*) What are the possible causes of a low contrast image? How can contrast stretching enhance images? Under what circumstances, dynamic range compression is needed to achieve image enhancement?	06
	(*iii*) Derive how two-dimensional sampling lattice can be used to represent a digital version of an image.	05

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Time: Three hours **Full Marks 100**
(50 marks for each part)

Use a separate Answer-Script for each part

	PART-II	Marks
	Answer any three, 2 marks for well-organized answers (16 X 3 + 2 = 50)	
1.	a) State and prove 2-dimensional discrete convolution theorem.	6
	b) Prove that the 2-dimensional discrete Fourier Transform is a linear operation.	4
	c) Consider a spatial mask that averages the four closest neighbors of a point (x,y) on a 2-dimensional space, but excludes the point itself from the average. Find the equivalent filter $H(u,v)$ in the frequency domain. Symbols carry their usual meaning.	6
2.	a) Explain ***Erosion*** and ***Dilation*** operations in the context of Morphological Image Processing.	2+2
	b) A grayscale image is shown below: $\begin{bmatrix} 10 & 100 & 128 \\ 4 & 56 & 22 \\ 36 & 64 & 2 \end{bmatrix}$ A 3x3 structuring element is given as: $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ Show the outputs for both ***Morphological Erosion*** and ***Dilation*** operations on this image using zero padding.	12
3.	a) What is an ***eigenface*** in the context of face recognition.	2
	b) Two images are given as: $A = \begin{bmatrix} 1 & 2 & 12 \\ 4 & 16 & 8 \\ 0 & 5 & 2 \end{bmatrix}$ & $B = \begin{bmatrix} 0 & 12 & 4 \\ 4 & 10 & 7 \\ 6 & 4 & 2 \end{bmatrix}$ Compute the ***eigenfaces*** from the image dataset formed by these two images. Show necessary steps of operation.	14

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Use a separate Answer-Script for each part

4.	a) Explain ***"orthonormal bases"*** in the context of wavelet transform.	2
	b) A grayscale image is shown below: $\begin{bmatrix} 1 & 3 & 7 & 9 \\ 4 & 9 & 12 & 16 \\ 10 & 4 & 6 & 2 \\ 15 & 12 & 2 & 1 \end{bmatrix}$ Compute the **Haar Transform** of this 4X4 image. Explain the significance of the transformed output.	12+2
5.	**Write short notes on *any two*** a) Kernel Principal Component Analysis b) Various types of noise contaminations relevant in image processing c) Convolutional Neural Network d) Morphological ***opening*** and ***closing*** operations in image processing	(2X8=16)