Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, DECEMBER 2020

APPLICATIONS OF DSP [ELE 4014]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 28 December 2020** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. What is an eigen function? Mention the eigen function for 2D discrete space LSI systems and also prove it. ***(02)***

1B. State and prove the continuous space Fourier transform of the rotated and translated image $\boldsymbol{f}(\mathbf{A}\bar{\mathbf{x}} + \bar{\mathbf{b}})$, where $\mathbf{A}$ is a (2×2) rotation matrix, $\mathbf{b}$ is the translation vector, and $\boldsymbol{x}$ is the argument vector of the function $\boldsymbol{f}$ in 2D. ***(04)***

1C. Perform the linear convolution between the following sequences:

$f(x,y) = \begin{bmatrix} \underline{1} & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$; $h(x,y) = \begin{bmatrix} \underline{1} & 1 \\ 1 & 1 \\ 1 & 1 \end{bmatrix}$. _ : sample at location (0, 0). ***(04)***

2A. Filter the following (5×5) 3-bit image using a (3×3) neighborhood weighted averaging method. Assume the mirror boundary conditions on the boundary of the image.

1	2	3	0	2
4	2	5	2	1
1	2	6	5	3
2	4	6	5	7
1	2	3	4	5

(04)

2B. What is histogram of an image? How do you achieve histogram equalization? ***(02)***

2C. Analyze a (3×3) Sobel filter in the frequency domain and prove that it performs smoothing before detecting edges (Hint: use separability of the Sobel kernel and apply FT). ***(04)***

3A. Derive an expression for the 2D Laplacian operator. Extend it to derive an expression for 2D Laplacian-of-Gaussian (LoG). Assume a unit valued, zero mean, and constant variance Gaussian. Draw waveforms for the Gaussian and its first and second derivatives. ***(04)***

3B. Identify the salt and pepper noise location in the 8-bit image given below:

124	122	133	125	132	000
000	255	124	000	126	123
255	121	132	131	128	255

Perform (3 × 3) weighted median filtering on the image assuming pixel replication on the boundary of the image. ***(03)***

3C. Explain the scaling, translation, and shearing operations on a shape of interest with relevant diagrams and transformation equations in 2D. ***(03)***

4A. With relevant equations explain Otsu's multi-thresholding algorithm. ***(02)***

4B. What do you understand by 'noise' in image processing? Explain any three noise models. ***(03)***

4C. What is active contour-based segmentation? Explain the shape-template design and mathematical modeling of the cost function optimization of the elliptical shape template. ***(05)***

5A. What is normalized cross-correlation? Prove that it is same as cosine similarity measure. ***(02)***

5B. Explain the DCT-based image compression method. Also, derive expressions for 1D-DCT using DFTs. ***(04)***

5C. Perform the hit-or-miss operation using the structuring elements B_1 and B_2 in Fig. (5B1) on the image given in Fig. (5B2).

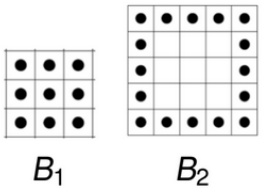

Fig. (5B1)

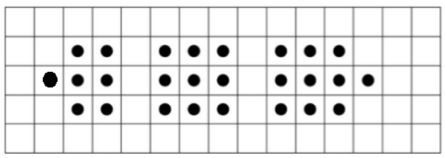

Fig. (5B2)

(04)