Reg. No.									

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

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
ONLINE EXAMINATIONS, JANUARY- FEBRUARY 2021

APPLICATIONS OF DSP [ELE 4014]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 29 January 2021** **Max. Marks: 50**

Instructions to Candidates:

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

1A. (i) Identify the function $f(x,y) = e^{-(x^2+y^2)/2}$. Is it a multiplicatively separable function?
(ii) Does the Fourier transform of this function is multiplicatively separable? Prove or disprove it. ***(03)***

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

$$f(x,y) = \begin{bmatrix} \underline{\mathbf{1}} & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}; h(x,y) = \begin{bmatrix} \underline{\mathbf{1}} \\ 1 \\ 1 \end{bmatrix}.$$

Note: Zeroth sample is bold and underlined. ***(04)***

1C. State and prove the Parseval's theorem for continuous space Fourier transform. ***(03)***

2A. Consider the two-dimensional function $f(x,y) = sinc^2(x)\, sinc^2(y) \cos(4\pi x)\, \cos(6\pi y)$, where $\text{sinc}(x) = \frac{\sin \pi x}{\pi x}$. Compute the two-dimensional Fourier transform of $f(x,y)$ using properties. Does the Fourier transform compactly supported in the frequency plane? Mention an optimal sampling and reconstruction strategy for $f(x,y)$. ***(05)***

2B. What is histogram and its equalization? Perform histogram equalization of the 3-bit image given below:

4	4	5	4	4
3	4	5	4	3
5	5	5	5	5
3	4	5	4	3
4	4	5	4	4

(03)

2C. Explain bit plane slicing technique of an image? What would be the effect on the histogram if we set to zero the higher-order bit plane? ***(02)***

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

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

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

3B. Derive an expression for the 2D Laplacian operator. Extend it to derive an expression for 2D Laplacian-of-Gaussian (LoG) for a zero mean, 'σ' variance, and unnormalized Gaussian. Draw waveforms for the Gaussian and its first and second derivatives. Also, compare it with the difference-of-Gaussian (DoG) operator. ***(04)***

3C. Explain impulse, periodic, and speckle noise models. ***(03)***

4A. What is matched filtering? Explain *cosine similarity measure* to detect the region of interest in an image. ***(02)***

4B. An (8×8) image $f(x, y)$ has gray levels given by the following equation:

$$f(x, y) = |x - y|; \qquad x, y = 0, 1, 2, 3, 4, 5, 6, 7.$$

Find the output image obtained by applying a (3×3) weighted mean filter on the image $f(x, y)$; keep the image border (boundary) pixels unchanged. ***(03)***

4C. What is image segmentation? Explain mathematical modeling of the cost function of the circular shape-template based image segmentation. ***(05)***

5A. Perform the hit-or-miss operation using the structuring elements B_1 and B_2 in Fig. (5A1) on the image given in Fig. (5A2).

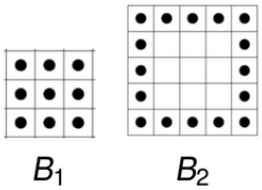

Fig. (5A1)

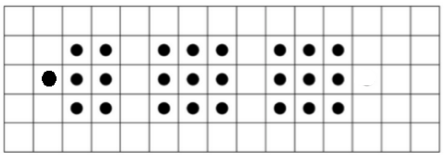
Fig. (5A2)

(03)

5B. (i) Explain the algorithm of DCT-based image compression technique.

(ii) Derive expressions for 1D-DCT using DFTs. Use the same to write expression for 2D-DCT. List the uses of DCTs. ***(05)***

5C. Suggest a unified approach to perform translation, scaling, and rotation. Explain how to achieve them. ***(02)***