Reg. No.



SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION DECEMBER 2020/JANUARY 2021 SUBJECT: DIGITAL IMAGE PROCESSING (ECE - 4006)

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.
- 1A. Calculate the 4-point 2D DCT for the following sub-image in the coloured cell.

5	2	5	0
0	1	3	1
2	1	1	1
1	2	2	-1

1B. Assuming continuous intensity values suppose that an image has the intensity PDF $p(r) = \frac{2r}{(L-1)^2}$ for r between 0 to L-1 and p(r) = 0 for other values for r. Find the

transformation function that will produce an image whose intensity PDF is $p(z) = \frac{3z^2}{(L-1)^3}$ for all z and p(z) = 0 for other values of z.

1C. Arrange the following 2D DCT coefficient in the zig-zag order.

-145	-30	-61	27	56	-20	-2	0
4	-22	-61	10	13	-7	-9	5
-47	7	77	-25	-29	10	5	-6
-49	12	34	-15	-10	6	2	2
12	-7	-13	-4	-2	2	-3	3
-8	3	2	-6	-2	1	4	2
-1	0	0	-2	-1	-3	4	-1
0	0	-1	-4	-1	0	1	2

(4+3+3)

2A. Compute the 2D Fourier transform for the following 2D function:

 $f(x, y) = \sin 4\pi x + \cos 6\pi y$

$$f(x, y) = \sin(2\pi x + 3\pi y)$$

$$f(x, y) = \sin(3\pi x)\cos(5\pi y)$$

2B. Illustrate the morphological method to extract the boundary of the following object. (A;Object B: Structuring element).



2C. Find the Fourier transform, H(u,v) of this mask in the frequency domain.

$$h = \begin{bmatrix} 0 & 0 & -1 & 0 & 0 \\ 0 & -1 & -2 & -1 & 0 \\ -1 & -2 & 16 & -2 & -1 \\ 0 & -1 & -2 & -1 & 0 \\ 0 & 0 & -1 & 0 & 0 \end{bmatrix}$$

What type of filter is this, LPF, BPF or HPF? Justify your answer.

(4+3+3)

3A. Show that the Laplacian operator defined below is isotropic.

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

$$x = x'\cos\theta - y'\sin\theta$$
 and $y = x'\sin\theta + y'\cos\theta$

- (x, y) are unrotated and (x', y') are rotated coordinates.
- 3B. Explain region based image segmentation. With an example describe split and merge technique.
- 3C. Estimate the pixel values in the question marked position shown in figure below by performing the spatial mean filters.



(4+3+3)

4A. Encode the message "lluure" for the given probability distribution for symbol set using Arithmetic coding.

Symbol	Probability
k	0.025
1	0.2
u	0.1
W	0.025
e	0.3
r	0.2
?	0.05

4B. The figure below shows the histogram of an image p(f) and the desired histogram g(f). Find the transformation function between them.



4C. Explain the Marr-Hilderth edge detector.

(4+3+3)

5A. Illustrate the concept of histogram specification for the following sub-image with 4X4 matrix of a 3 bit image and the specified histogram as shown below



- 5B. Consider a 3X3 spatial mask that averages the four closest neighbours of a point (x, y), but excludes the point itself from the average, find the equivalent filter H(u, v) in the frequency domain. Show that the result is a low pass filter.
- 5C. Define 4-8 and m- adjacency. Compute the lengths of the shortest 4- 8- and m- path between p and q in the image segment as shown below by considering $V = \{2, 3, 4\}$. Point p(4, 0) and point q(0, 4).

3(p)	4	1	2	0
0	1	0	4	2
2	2	3	1	4
3	0	4	2	1
1	2	0	3	4(q)

(4+3+3)