Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

VII SEM B.Tech (BME) DEGREE END-SEMESTER EXAMINATIONS, DEC. 2020.

SUBJECT: ADVANCED IMAGE PROCESSING (BME 4102)
(REVISED CREDIT SYSTEM)
Wednesday, 23rd December 2020, 2 to 5 PM

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to Candidates:

1. **Answer ALL the questions.**
2. **Read all the questions carefully, and answer *adequately* – but, *to the point*.**

1. (a) It is desired to filter a 2D image of size 250×475, by the unit sample response $h(m,n)$ of size 51×51. A student is asked to implement the filtering operation by using a *Radix*-2 FFT algorithm. Write the block diagram describing the precise steps in implementing the filtering operation. Calculate the values of all the parameters involved. (3)

(b) Assume a continuous image, whose gray level is represented by the random variable (RV) X, whose probability density function is given by the expression:

$$f_X(x) = \frac{g_X(x)}{\int g_X(x)dx}, \quad \text{where :} \quad g_X(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-6)^2}{2\sigma^2}} - \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(5.5)^2}{2\sigma^2}}, \quad x \in [5.5,6.5]$$

$$= 0, \qquad \text{otherwise}$$

(2)

Let Y be the RV representing the probability density function of the *histogram-equalized version* of the original image.

Sketch the cumulative distribution function (*cdf*) associated with the RV Y. Justify your answer.

(c) (i) Perform histogram equalization of the image shown in the accompanying figure (Fig. 1).

Sketch the output image, and its histogram. (3)

9	1	11	11	11	11	11	7
12	12	11	11	11	11	11	11
12	12	11	11	11	11	11	11
12	12	11	11	11	11	11	11
12	12	11	11	11	11	11	11
12	12	11	11	11	11	11	11
12	12	12	12	12	12	12	11
12	12	12	12	12	12	12	12

***Figure* 1**

(ii) Compare the *cdf* with the *cdf* you have sketched in response to Q. 1(b); write your observations and comments. (2)

2 (a) Given the information that the DCT matrix $\boldsymbol{C}$ is orthonormal, prove that $\boldsymbol{C}$ is merely a *rotating transform*. (2)

(b) (i) Develop <u>from the fundamentals</u>, the convolution-mask (matrix) for computing the Laplacian of an image. (3)

(ii) How would you use the mask to get the edge-points in the image? (1)

(iii) Explain as to why, the step in (ii) would not be sufficient to get an image with robust edges.

What would you do – to make the method robust (explain clearly, with mathematical details where ever necessary). (1) (2)

(c) You are given a vertical edge-detector mask. Consider an image with edges oriented at 30 degrees. How would you use the given mask for detecting edges in the given image. (2)

3. (a) Write a *pseudo-code* for detecting the presence of vertical lines in an image, by the Hough transform technique. (3)

(b) (i) Let $\mu_{p,q}$ be the central moments of a function (object) $f(x,y)$. Consider another function $g(x,y)$, which is a rotated version of $f(x,y)$ (let us say, by 25 degrees). How would you compute the angle between the two objects, using their central moments? (2)

(ii) Compute the values of $\mu_{p,q}$, $\forall\ p\ \&\ q\quad (p+q \le 3)$ associated with the following objects, respectively:

* a square object extending from –1 to +1 along either of the axes; the intensity of the object within the square boundary is 1. (*3 Marks*)

* the object shown in the accompanying figure (Fig. 2); the gray-level within the object-boundary uniform, with a cluae of 6, and the intensity elsewhere ('background-') is 0. (*2 marks*)

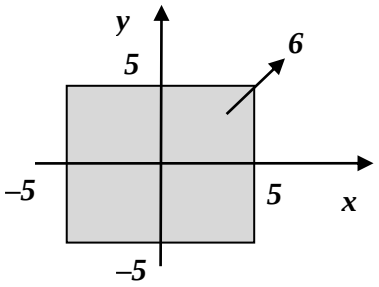

***Figure* 2**

(5)

4. (a) Write a *pseudo-code* to implement the rotation of an object, in an image of size 511X511, clockwise by 36 degrees, with respect to its *centroid*, $\boldsymbol{c}$. (3)

(b) Sketch the opening and closing of the object shown in Fig. 3 (a), by the structuring element in Fig. 3(b). All the intermediate results must be sketched with clarity and geometric details. (4)

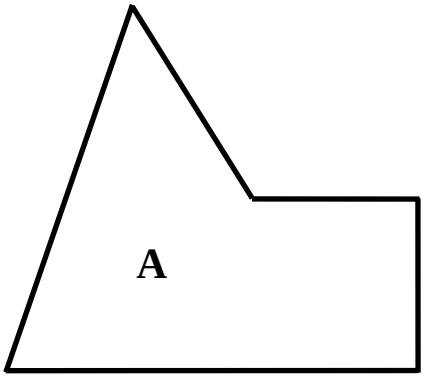

***Figure* 3(a)**

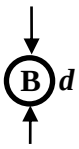

***Figure* 3(b)**

(c) Find the number of objects ('blob's) in the figure given in the following (Fig. 4), using the principles of connected component labeling, based on (i) 8 neighborhood, (ii) 4-neighborhood, and (iii) *d*-neighborhood. Mark the neighborhoods/neighbor-index and/or equivalence-tables, if any, in the all the three cases, to justify your answer. (3)

***Figure* 4**

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	**1**	0	0
1	0	0	0	**1**	0	**1**	0
0	**1**	0	**1**	0	0	0	**1**
0	0	**1**	0	0	0	**1**	0
0	0	0	0	0	**1**	0	0
0	0	0	0	0	0	0	0

5. (a) Explain the RGB- and CMYK- colour models. (2)

(b) (i) How would you justify colour-pixel-classification to enable the segmentation of specific regions of importance, on the wound-bed?

Write down the steps in the procedure for classifying the pixels on a wound-bed, towards assessing the condition of the wound. (5)

With appropriate expressions/figures, justify clearly, the distance-measure used in the process.

(ii) In the context of *digital TB screening* involving analyzing the digital images of ZN-stained sputum smears, discussed in the class, is the use of *proximity-test algorithm* sufficient to classify a beaded bacillus from a clump? If so, explain how? If not, explain the reason, and indicate a solution. Clear answers are paramount to the marks you wish to earn. (3)