Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

VI SEM B.Tech (BME) DEGREE MAKE-UP EXAMINATIONS, JUNE 2019.

SUBJECT: MEDICAL IMAGE PROCESSING (BME 3203)
(REVISED CREDIT SYSTEM)
Wednesday, 12Th June 2019, 2:00 to 5:00 PM

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

Instructions to Candidates:

1. **Answer ALL questions.**
2. **Read all the questions carefully, and answer concisely (*adequately*, but *to the point*).**
3. **Draw labeled diagram wherever necessary**

1. (a) A system is described by its input-output relationship: $y(m,n) = a\,|x(m,n)|$. Find out if the system is (i) linear, (ii) shift-invariant, and (iii) causal. Justify your answers mathematically. (3)

(b) A system is described by the input-output relationship:
$y(m,n) = ax(m,n) + bx(m-1,n) + c\,x(m+1,n) + dx(m,n-1) + ex(m,n-1)$.

(i) Find the convolution-mask associated with the system. (1)

(ii) Find the expression for the frequency-response of the system and simplify it. (1)

(c) It is often sufficient to derive the results in 1D, to understand the behavior of a 2D system – by a straight-forward extension. Accordingly:

(i) Prove that: $\text{DSFT}\{x(m) * h(m)\} = X(e^{j\omega})H(e^{j\omega})$ (DSFT: discrete-space Fourier transform) (2)

(ii) In Figure 1, a discrete LSI system with impulse response sequence $h(m)$ is shown. Determine the expression for "λ". (2)

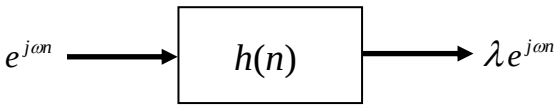

Figure 1

What would be the value of λ, if $h(n) = \delta(n)$? Justify your answer mathematically. (1)

2. (a) Describe the *monochrome vision model* with a suitable block-diagram. Explain the content/working of each block. (5)

(b) (i) What are the possible types of degradation associated with an image is compressed using the DCT? Explain briefly, the sources of those types of degradation. (3)

(ii) Indicate two advantages, and two disadvantages, of compressing an image by *thresholding* the DCT coefficients. (2)

3. (a) (i) Find the output of the 3×3 Median filter (MF) on the image in Fig. 2. (3)

(ii) By marking the appropriate pixels on the result (filtered image), list the drawbacks of the 3×3 median filter. (1)

(iii) Suggest a solution to <u>overcoming the drawbacks</u> of the 3×3 median filter. (1)

0	7	7	7	7	7	10	10	10
0	7	10	7	0	7	10	10	10
0	7	7	7	7	7	10	10	10
0	10	10	10	10	10	10	10	10
0	7	7	7	7	7	7	7	7
0	7	7	7	7	7	7	7	7
0	1	2	3	4	5	6	7	8
0	1	2	3	4	5	6	7	8
0	1	2	3	4	5	6	7	8

<u>Figure 2</u>

(iv) Demonstrate, by showing relevant pixels in your result, the correctness of the solution you have proposed in answer to question (iii). (2)

(b) Find the output of the averaging filter (whose mask is shown in the adjacent figure ie.g., Fig. 3) **on the image in Fig. 2.** (3)

<u>Figure 3</u>

	0.2	
0.2	**0.2**	**0.2**
	0.2	

4. (a) The formula for *reconstructing an image* from a set of projections $\{ p_\theta(t) \}$, is given

in two steps: $$f(x,y) = \int_0^{\pi} \tilde{p}(x\cos\theta + y\sin\theta)d\theta, \quad \forall (x,y)\, \varepsilon\, ROI$$ (Region of Interest)

where: $$\tilde{p}(t) = \int_{-\infty}^{\infty} p(\alpha)h(t-\alpha)d\alpha$$

(i) Discretize the formula. (2)

(ii) Based on the discretized formula, write the steps involved in *reconstructing an image on a discrete grid, from a finite set of discrete projections*. Use *linear interpolation* when required. (3)

(iii) Write a *pseudo code* to implement the steps you have given in answer to the preceding question. (3)

(b) What is the main difference between the CBP algorithm for reconstruction from fan-beam, and that for reconstruction from parallel-beam? Explain. (2)

5. (a) (i) Explain the system associated with, and the working of a 3rd generation CT system. (2)

(ii) What are the two advantages of the 4Th generation CT system, over that of the 3rd generation system. (1)

(b) Explain "electronic collimation" in the context of emission CT. (2)

(c) In the context of Magnetic resonance imaging (MRI):

(i) Draw the magnetic vector diagram that explains the dynamics of the fields on the application of a 90^0 pulse, and explain the same. (3)

(ii) Explain the functioning of a *frequency-encoding gradient*, towards resolving spatial locations. (2)