Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

II SEM M.Tech (BME) DEGREE END-SEMESTER EXAMINATIONS, APRIL-MAY 2019.

SUBJECT: MEDICAL IMAGE PROCESSING (BME 5201)
(REVISED CREDIT SYSTEM)
Saturday, 27Th April 2019, 2 to 5 PM

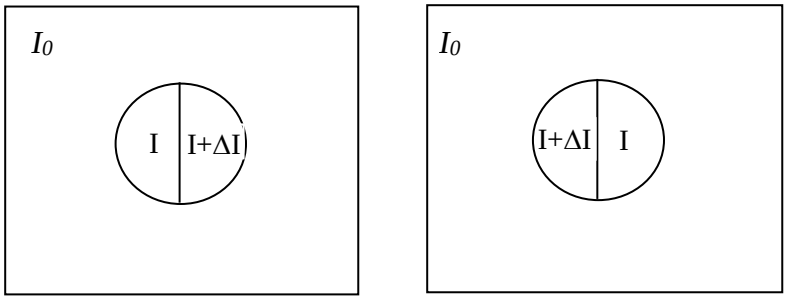
TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to Candidates:

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

1. (a) Consider the experiment to determine the *adaptability of the human vision system*. The experimental set-up, and the relevant parameters are as shown in Fig. 1(a). "*I*" is the illumination over the region of interest (ROI, or the "object"), "I_0" is the intensity of the background, and ΔI is the just noticeable difference with respect to the ROI.

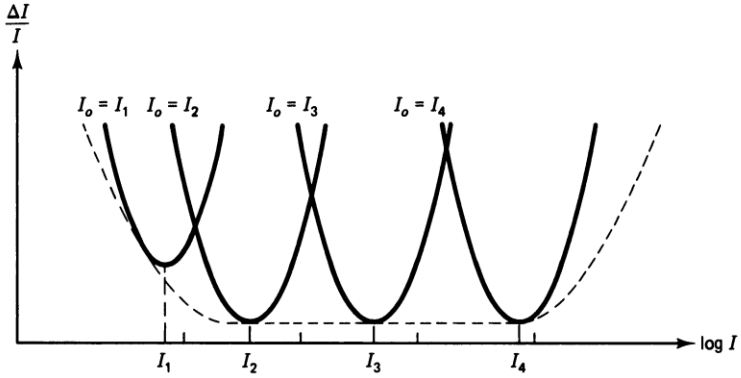
Figure 1 (a)



(5)

The results of the experiments are shown in the graph in Fig. 1(b):

Figure 1 (b)



Explain the experiment, and the resulting graph, concisely.

(b) (i) What are the essential properties of the DCT, for it to be useful in image compression? Explain each concisely (a line or two per property). (3)

(ii) What are the two main advantages of splitting a large image into smaller blocks, and coding them independently? Explain concisely but clearly. (2)

2. (a) (i) Find the output of a Median Filter (MF) based on a 3×3 cross-shaped neighborhood shown in Fig. 2(a), on the image in Fig. 2(b). (3)

	X	
X	X	X
	X	

Figure 2(a)

Figure 2(b)

5	5	5	5	5	6	6
5	5	12	5	5	6	6
5	0	5	5	5	6	6
5	5	5	5	5	6	12
6	6	6	6	6	12	6
5	6	6	6	12	6	6
6	6	6	12	6	6	6
6	6	12	6	6	6	6

(ii) List the important achievements of the MF – by pointing out to the relevant pixels in the result. (1)
IMPORTANT: Blind, irrelevant points will fetch *penal marks* (–0.5 per point).

(iii) Do you observe any **drawback** of this MF Support? Indicate clearly, by pointing out to the relevant pixels in your result. (1)

(iv) Suggest a support of the MF, to overcome the drawback indicated in (iii). Justify your answer by showing the output at at least two relevant pixels on the image. (1)

(v) Can your support, however, affect something else? If so, show the relevant (affected) pixel(s). (1)

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

Figure 3

	0.5	
0.5	0.5	0.5
	0.5	

3. (a) (i) Perform histogram equalization of the image in **Fig. 2(b)** [given in Q. 2(a)]**.** (3)

(ii) If the just noticeable difference associated with an observer is 3 units, comment on the performance of the method. (1)

(b) (i) In the context of gradient-based edge-detection, starting from fundamentals, find the approximation to the digital gradient (in the X-direction), so that it is *robust to the presence of noise*. (2)

(ii) Using the development in (i) in this question, find the 2D gradient mask. (2)

(iii) Using the developments in (i) and (ii), develop the complete gradient-based edge-detection scheme. A suitable block-diagram would be helpful. (2)

4. (a) State the central slice theorem, and illustrate the same using proper mathematical expressions & a suitable diagram. (2)

(b) (i) The formula for computing the backprojection from a set of projections $\{ p_\theta(t) \}$, is given by: $b(x,y) = \int_0^\pi p(x\cos\theta + y\sin\theta)d\theta, \quad \forall (x,y)\, \varepsilon\, ROI$ (Region of Interest)

(i) Discretize the formula. (1)

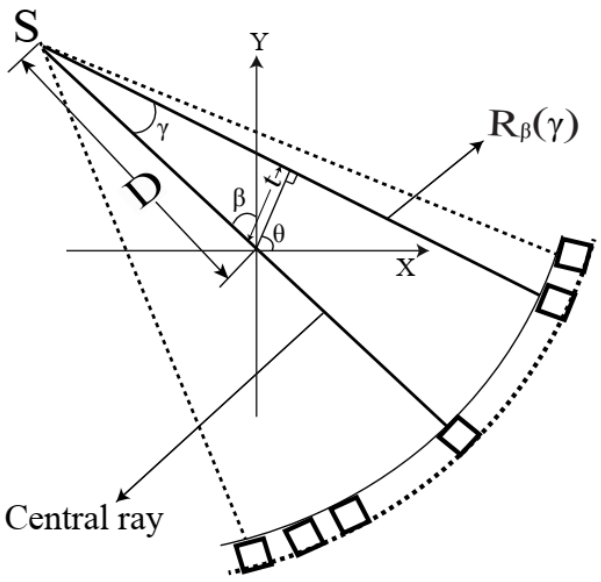
(ii) Write the steps involved in *computing* the backprojection (only). Use the *nearest neighbor method*, in the interpolation-step. You must define all the parameters used. (2)

(iii) Write a *pseudo code* to <u>implement backprojection</u> (only) from a set of discrete projections, using the nearest-neighbor method in the interpolation-step. NOTE: Unnecessary/irrelevant steps (or instructions) will invite *penal marks*. (3)

(c) Derive the relationship between the parameters pertaining to a line, for the purpose of rebinning i.e., resorting the data from the fan-beam geometry (β,γ) to parallel-beam geometry (θ,*t*).

You may wish to refer to the fan-beam scanning geometry in the adjacent Figure (Fig. 4). (2)

Figure 4:



5. (a) Explain briefly, the system associated with, and the working of electron-beam CT. (2)

(b) In the context of Magnetic resonance imaging (MRI): explain T_1-weighted imaging, using a suitable pulse sequence. In other words, explain as to how a tissue *A* with a lower value of T_1, can be distinguished in the image, from another tissue *B* with a higher value of T_1. (3)

(c) (i) Explain the concepts of hue (*H*), saturation (*S*), and intensity (*I*). (2)

(ii) How would you use the *HSI* model to segment bacilli from ZN-stained sputum smears of a TB-patient? Explain concisely. (3)