Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

I SEM M.Tech (MI) DEGREE END-SEMESTER EXAMINATIONS, NOV/DEC 2023

SUBJECT: MEDICAL INFOORMATION ANALYSIS (BME 5117)
(REVISED CREDIT SYSTEM)
Saturday, 02nd December, 2023, 9:30 AM to 12:30 PM

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

Instructions to Candidates:

1. Answer ALL questions.
2. Draw labeled diagram wherever necessary

1. a) Explain the significance of EEG frequency bands in the analysis of brain activity. (2M)

   b) Explain each operation performed on the sequences $x(n) = \begin{cases} n & -3 \le n \le 3 \\ 0 & otherwise \end{cases}$ to represent the resultant sequence $y(n) = x(-2n + 1)$ (3M)

   c) Determine the typical normal ranges and units of representation for ECG, EEG, EMG, EDA, and speech signals. Highlight how deviations from normal ranges can aid in diagnosis and clinical interpretation. (5M)

2. a) Consider the FIR High pass filter defined by the system function $H(z) = \frac{1}{2}(1 - z^{-1})$. Determine the characteristics of the system from its magnitude and phase spectrum. (2M)

   b) Propose an optimal filter to remove the stationary interference present in the Biomedical signals. (4M)

   c) Design an IIR digital Low Pass filter for the specifications as shown in Figure 1 by transforming an analog Low Pass filter using Bilinear transformation. Consider analog Butterworth Low pass filter design for the given specifications. (4M)

Reg. No.											

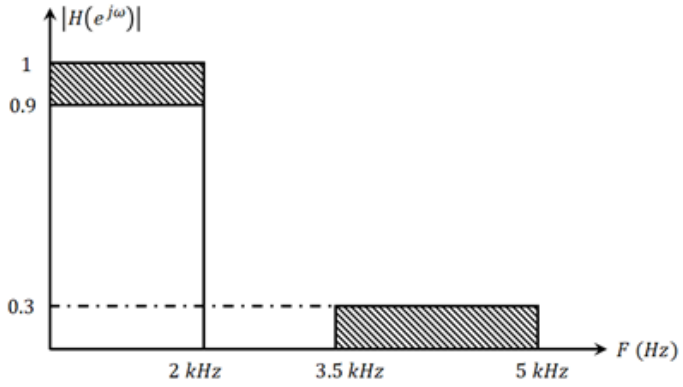

Figure 1

3. a) Consider the IIR Low pass filter defined by the system function $H(z) = \frac{1-\alpha}{2}\frac{1+z^{-1}}{1-\alpha z^{-1}}$. Design the filter for the $\frac{\pi}{4}\ radians/sample$ cut off frequency. (2M)

b) Draw a block diagram representing various steps in the Pan-Tompkins method to detect QRS complex in ECG signals. Explain the purpose and nature of each step in the procedure. (3M)

c) Determine the length of the shortest path from (i) (1, 1) to (3, 4) (ii) (1, 6) to (3, 2) using (a) 4-connectivity and (b) 8-connectivity (5M)

4. a) Illustrate what causes ringing artefact in frequency domain filtering. How do you prevent the artefact? (3M)

b) A 2x2 image has the pixel values $\begin{bmatrix} 6 & 7 \\ 3 & 9 \end{bmatrix}$. Compute parallel-ray projections of the image at 0° and 45° (2M)

c) The 5×5 image

$$f(m,n) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 10 & 10 & 10 & 0 \\ 0 & 10 & 10 & 10 & 0 \\ 0 & 10 & 10 & 10 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$ (5M)

is processed by two systems in cascade.

The first system produces the output $g_1(m,n) = f(m,n) - f(m-1,n)$.

The second system produces the output $g_2(m,n) = g_1(m,n) - g_1(m-1,n)$.

Compute the images g_1 and g_2. Explain the effects of two operators.

Reg. No.											

5. a) Justify how does a set of projections at different viewing angles relate to the Fourier transform of an object (2M)

   b) Illustrate the steps of computation required in order to perform Low pass filtering of an image in the frequency domain by using the Fourier transform. (3M)

   c) Filter the following image using a 3x3 neighborhood averaging filter by assuming zero padding (5M)

5	6	3	2
4	5	5	1
1	2	6	3
2	6	4	7