Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

I SEM M.Tech (MI) DEGREE MAKEUP EXAMINATIONS, FEB 2023.

SUBJECT: Medical Information Analysis (BME 5171)

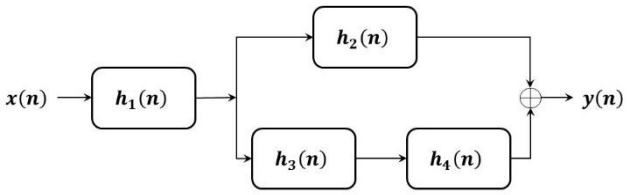
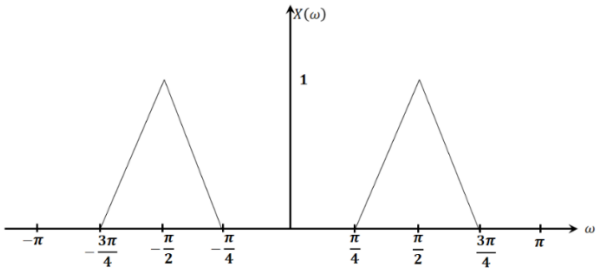
(REVISED CREDIT SYSTEM)

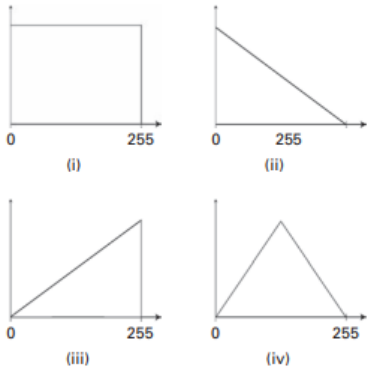
Tuesday, 17th February, 2023, 9:30 to 12:30 AM

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

Instructions to Candidates:

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

1.	a)	A biomedical signal is bandpass filtered to the range $0-200\ Hz$. Assume the filter to be ideal and assume any distribution of spectral energy over the bandwidth of the signal. **(i)** what is the minimum frequency at which the signal should be sampled to avoid aliasing error? **(ii)** A researcher samples the signal at 500 Hz. Draw a schematic representation of the spectrum of the sampled signal. **(iii)** Another researcher samples the signal at 200 Hz. Draw a schematic representation of the spectrum of the sampled signal. **(iv)** Explain the difference between case (ii) and (iii).	(5M)
	b)	Consider the interconnection of LTI systems as shown in **Figure below**. Determine the impulse response $h_4(n)$ of sub-LTI system that will yield the overall impulse response $h(n)=\frac{7}{8}, \forall n$ when $h_1(n)=\left\{\frac{1}{2},\frac{1}{4},\frac{1}{8}\right\}$, $h_2(n)=h_3(n)=u(n)$. 	(3M)
	c)	Let $x(n)$ be a signal with the Fourier Transform as shown in **Figure below**. Determine and sketch the Fourier Transform of the following signal $y(n)=x(n)\,cos\left(\frac{\pi n}{2}\right)$. 	(2M)
2.	a)	With a block diagram represent various steps in the Pan-Tompkins method to detect QRS complexes in ECG signals. Explain the purpose and nature of each step in the procedure,	(5M)

		including detection of the peaks in the output corresponding to the QRS complexes. ***(No equations are required in your answer)***	
	b)	Design the Type-4 linear-phase FIR filter with the following zeros: $z_1 = 2.2 + j3.4,\ z_2 = 0.6 + j0.9, z_3 = -0.5$.	(3M)
	c)	Consider the FIR filter defined by the system function $H(z) = \frac{1}{2}(1 + z^{-2})$. Determine the characteristics of the system from its magnitude and phase spectrum.	(2M)
3.	a)	A researcher has been hired to develop a software package for the analysis of 10-channel EEG signals to detect the spike-and-wave complexes of a prespecified shape in any channel. Design signal processing package to address this problem by providing the following details: **(i)** A schematic block diagram representing the various signal processing steps that you recommend. **(ii)** Explain each block with a reason or logic behind your recommendation.	(5M)
	b)	Draw schematic diagrams of the Fourier spectra of the following images: (i) A rectangle with a horizontal side twice the length of the vertical side. (ii) The rectangle is rotated 45° clockwise. (iii) The rectangle in scaled down by a factor of two.	(3M)
	c)	During digitization samples are taken a distance Δx apart: what is the highest frequency allowed in the image to avoid aliasing?	(2M)
4.	a)	Perform the 2D linear convolution between the two signals $x(m,n) = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ and $h(m,n) = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$.	(4M)
	b)	Explain the Fourier Slice Theorem.	(4M)
	c)	Give a few applications of morphological operations in the field of image processing.	(2M)
5.	a)	List the steps of computation required in order to perform frequency domain low pass filtering of an image using the Fourier transform. (no need to give any equation)	(4M)
	b)	Sketch the corresponding cumulative distribution functions, CDFs, for the probability density functions, PDFs shown in Figure given below. 	(4M)
	c)	Sketch the 3 × 3 weighted average spatial mask that performs smoothing in a single pass through an image	(2M)