Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

DEPARTMENT OF MECHATRONICS

V SEMESTER B.TECH. (MECHATRONICS)

MAKEUP EXAMINATIONS, DECEMBER 2022

SUBJECT: DIGITAL SIGNAL PROCESSING [MTE 3151]

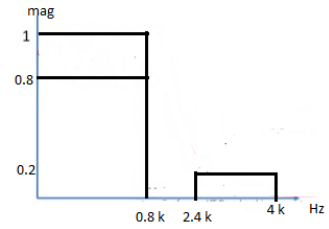
(06/01/2022)

Time: 3 Hours **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- *Data not provided, may be suitably assumed*

Q. No		M	CO	PO	LO	BL
1A.	Determine whether the following signals are periodic. If they are periodic, find the fundamental period (a) $x_1[n] = cos(n)$ (b) $x_2[n] = \cos\left(\frac{1}{5}\pi n\right)\sin\left(\frac{1}{3}\pi n\right)$ (c) $x_3[n] = \sum_{k=-\infty}^{\infty}\delta[n-3k]$ (d) $x_4[n] = 2\sin(\pi^2\ n)$	**5**	**1**	**1**	**1**	**3**
1B.	Calculate $h_d(n)$ for a High Pass FIR filter with N=7, and $\omega_p = 2\,rad.$	**3**	**3**	**3**	**5**	**5**
1C.	Develop cascade realization structure for the IIR digital filter transfer function $H(z) = \frac{1-z^{-1}}{(1-0.5z^{-1})(1+0.3z^{-1})}$	**2**	**3**	**3**	**5**	**3**
2A.	Compute the signal energy and signal power for the discrete-time signal (a) $y[n] = r\,[n]$ (b) $x[n] = \left(\frac{1}{2}\right)^n u[n]$	**4**	**1**	**2**	**2**	**5**
2B.	Estimate $H(z)$ using the impulse invariant technique for the analog system function $H_a(s) = \frac{2}{(s+1)(s+2)}$ Assume $T = 1s$.	**4**	**3**	**3**	**2**	**6**
2C.	Compute 4 pt DFT of causal sequence given by $x(n) = \begin{cases}\frac{1}{3}; 0 \le n \le 2\\ 0; otherwise\end{cases}$	**2**	**2**	**2**	**2**	**5**
3A.	Design a digital IIR that satisfies the following constraint using bilinear transformation. Assume $T = 2s$.	**5**	**3**	**3**	**5**	**4**

						
3B.	Convert the analog filter with transfer function $H_a(s)$ to digital filter using bilinear transformation. $$H_a(s) = \frac{1}{(s+1)(s+3)}$$	**3**	**3**	**2**	**2**	**3**
3C.	Draw the magnitude response of the filter for the given digital specifications Stopband ripple<= 15dB Passband edge =150Hz Passband attenuation>1dB Stopband edge =100Hz Sampling frequency =1kHz	**2**	**3**	**2**	**2**	**3**
4A.	A high frequency hum is getting interfered in a vocal recording, and as a sound engineer, you are asked to design a filter to remove those unwanted signals. Design a filter with 3 dB frequency = 1000π and stopband frequency =2000π. User requirement for attenuation in stopband ≥40dB.	**5**	**3**	**3**	**5**	**5**
4B.	Consider an LTI system, initially at rest, described by the difference equation $y(n) = 0.5y(n-1) - 0.25y(n-2) + x(n) + 0.4x(n-1)$ i) Determine the transfer function of the system. ii) Construct the direct form I and direct form II realization of this system and comment on the requirement of delay elements for the realization	**3**	**3**	**3**	**5**	**5**
4C.	Design the transfer function of 3rd order LPF using Butterworth approximation.	**2**	**3**	**2**	**5**	**5**
5A.	A linear phase digital filter is to be designed with 7 coefficients $\omega_p = 1\,rad$ i) Identify whether it a low-pass or high-pass. Justify your answer ii) Determine the impulse response $h(n)$ for a rectangular window. Comment of the responses.	**4**	**3**	**3**	**5**	**5**
5B.	Find the optimal order for the filter using Butterworth approximation method, for the given specifications. $0.9 \leq \lvert H(\omega) \rvert \leq 1; \quad 0 \leq \lvert \omega \rvert \leq 0.2\pi$ $\lvert H(\omega) \rvert \leq 0.2; \quad 0.4\pi \leq \lvert \omega \rvert \leq \pi$	**3**	**3**	**3**	**5**	**5**
5C.	Analyzing the working of machining processes and its condition monitoring is a significant requirement for ensuring safe and reliable working of industrial equipment. Describe the various signal processing methods which could be employed for analyzing the inputs for condition monitoring.	**3**	**4**	**2**	**2**	**6**