Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMENT OF MECHATRONICS

V SEMESTER B.TECH. (MECHATRONICS)

END SEMESTER MAKEUP EXAMINATIONS, JANUARY 2024

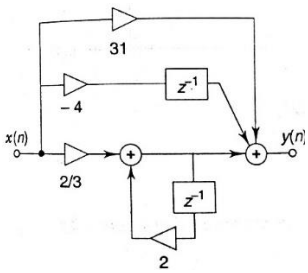
SUBJECT: DIGITAL SIGNAL PROCESSING [MTE 3151]

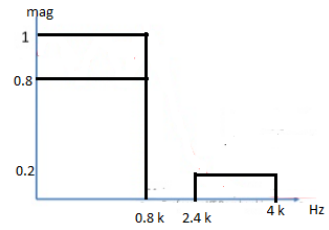
(11/01/2024)

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.	Find the optimal order for the filter using Butterworth approximation method, for the given specifications. $0.9 \leq \lvert H(\omega) \rvert \leq 1; \quad 0 \leq \lvert \omega \rvert \leq 0.2\pi$ $\lvert H(\omega) \rvert \leq 0.2; \quad 0.4\pi \leq \lvert \omega \rvert \leq \pi$	**5**	**3**	**2**	**2**	**3**
1B.	Design the transfer function of 4th order LPF using Butterworth approximation.	**3**	**3**	**2**	**1**	**4**
1C.	Compute 4 pt DFT of causal sequence given by $x(n) = \begin{cases} \frac{1}{2}; 0 \leq n \leq 2 \\ 0; otherwise \end{cases}$	**2**	**2**	**2**	**5**	**4**
2A.	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**	**4**
2B.	Obtain the system transfer function H(z) for the system shown 	**3**	**3**	**3**	**2**	**4**
2C.	Obtain the parallel realisation structure for the signal $H(z) = \frac{1 + \frac{1}{4}z^{-1}}{(1 - \frac{1}{2}z^{-1})(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2})}$	**3**	**3**	**3**	**3**	**4**

3A.	Design a digital IIR that satisfies the following constraint using bilinear transformation. Assume $T = 2s$. 	**5**	**3**	**3**	**5**	**5**
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**	**5**
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.	Obtain the cascade realisation for IIR Transfer function $$y[n] = \frac{3}{4}y[n-1] - \frac{1}{8}y[n-2] + x[n] + \frac{1}{3}x[n-1]$$	**3**	**3**	**3**	**5**	**3**
4C.	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**	**2**	**5**	**4**
5A.	Determine the direct Form I and II realisation for IIR Transfer function: $H(z) = \frac{6z(z^2-4)}{5z^3-4.5z^2+1.4z-0.8}$. Comment on the requirements of delay elements when implemented in a Digital Signal Processor.	**5**	**4**	**3**	**5**	**4**
5B.	An electrocardiogram (ECG or EKG) records the electrical signal from the heart to check for different heart conditions. Describe the various signal processing methods which could be adopted for analyzing such signals. Comment on the various applications for which those signal processing methods could be employed and the safety and risk factor involved in it.	**3**	**4** **5**	**3**	**5**	**4**
5C.	Determine the direct Form II realization for the third-order IIR Transfer function: $H(z) = \frac{0.28z^2+0.319z+0.04}{0.5z^3+0.3z^2+0.17z-0.2}$	**2**	**3**	**2**	**2**	**4**