Reg. No.										

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

V SEMESTER B.TECH. (MECHATRONICS)

END SEMESTER EXAMINATIONS, NOV 2019

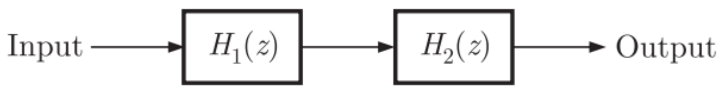
SUBJECT: DIGITAL SIGNAL PROCESSING [MTE 3105]

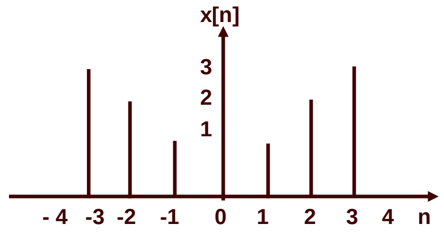
(20/11/2019)

Time: 3 Hours — MAX. MARKS: 50

Instructions to Candidates:

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

1A.	Analyze the output signal property in terms of causality with adequate validation for the following situation: A temperature signal is recorded by a sensor having the transfer function $H(z) = 3z^{-1} - 2$. The z-transform of an input temperature signal $x[n]$ is given by $4z^{-3} + 3z^{-1} + 2 - 6z^2 + 2z^3$ and the output of the sensor be $y[n]$.	**(4)**	CO1 CO2
1B.	Compute the energy and power of the following signal $x(t) = A\, e^{j\omega_0 t}$.	**(3)**	CO1
1C.	Calculate the transfer function of the second system $H_2(z)$, which is the part of the compound system shown in Fig. 1C. The output of this compound system is equal to the input with a delay of two units. The transfer function of the first system is given by $H_1(z) = \frac{z-0.5}{z-0.8}$.  **Fig. 1C**	**(3)**	CO2
2A	Two finite sequences $h[n]$ and $x[n]$ have the following Discrete Fourier Transforms (DFTs): $X = DFT\{x[n]\} = [1, -2, 1, -2]$ $H = DFT\{h[n]\} = [1, j, 1, -j]$ Let $y = h \otimes x$ be the four point circular convolution of the two sequences. Determine the following (without computing $x[n]$,and $h[n]$): (a) DFT $\{x[(n-1)_4]\}$ and DFT $\{h[(n+2)_4]\}$ (b) $y[0]$	**(4)**	CO2
2B	Illustrate the signal $x[n](u[-n-2] - u[n+2])$. The discrete time signal $x[n]$ is	**(2)**	CO1

	given in the Fig. 2B.  **Fig. 2B**		
2C	Construct the filter structure of the Infinite Impulse Response (IIR) filter by realizing its cascaded and parallel forms. The transfer function of the filter is given as follows: $$H(z) = -0.1 + \frac{0.6}{1 - 0.4\,z^{-1}} + \frac{-0.5 - 0.2z^{-1}}{1 + 0.8z^{-1} + 0.5z^{-2}}$$	**(4)**	CO3
3A	Discuss the need to over satisfy the specifications in the designing of the band pass IIR filter. Further, analyze, how can you to over satisfy the specifications rather under satisfy them. (Considering a user provides the specifications of filter design, which violates the symmetry condition)	**(4)**	CO3
3B	Discuss the following addressing modes used in the DSP Processor: (i) Direct addressing, and (ii) Immediate addressing.	**(2)**	CO4
3C	For a given digital FIR filter haing the transfer function $$H(z) = (1 + z^{-1})^2 (1 - z^{-1})^2$$ (i) Sketch the pole-zero diagram. (ii) Identify whether it a low-pass, high-pass, band-pass, or band-stop filter. (iii) Sketch $\left\|H\left(e^{jw}\right)\right\|$ and determine the 3dB cutoff frequency.	**(4)**	CO3
4A	Design the Finite Impulse Response (FIR) filter for the following problem: Assume, multiple number of sensors were installed in the robot to localize its position and orientation. Frequency range of few sensors were overlapping. Hence the processor couldn’t control the robot to follow desired trajectory. Design a practical FIR filter using Hamming windows to get the frequency component of a particular sensor which helps the robot to localize its position and orientation. The desired frequency response of the filter is given as follows: $$H_d(\omega) = \begin{cases} e^{-j3\omega}, -\frac{3\pi}{4} \leq \|\omega\| \leq \frac{3\pi}{4} \\ 0, \quad other\ wise \end{cases}$$	**(7)**	CO3
4B	Discuss the pipeline structure in TMS320C5x.	**(3)**	CO4
5A	Design an IIR filter using bilinear transformation and butterworth approximation for the following situation: Heavy rotating machines are the key component of the power generation of any	**(7)**	CO3

	plant. A small fault in the rotating machine is very difficult to identify, which may have frequency range either less than 25 Hz or more than 225 Hz. As the signals generating from other sources in the plant are in the range of 100 Hz to 150 Hz corrupted the desirable fault signal. Design a filter to identify the small fault in the rotating machine, which can be further helpful for safe operation. Please note, the above frequency ranges should be treated as the filter specifications i.e. lower pass band edge, upper pass band edge, lower stop band edge and upper stop band edge respectively. Assume: Passband ripple 3 dB, Stopband attenuation 18 dB, and sampling frequency 500 Hz.		
5B	Compare the IIR filter and FIR filter in terms of performance, stability and frequency response.	**(3)**	CO3