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

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER ON-LINE PROCTORED EXAMINATIONS

DECEMBER 2021

DIGITAL SIGNAL PROCESSING [ELE 3152]

REVISED CREDIT SYSTEM

Time: 75 Minutes + 10 Minutes **Date: 23 December 2021** **Max. Marks: 20**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Time: 75 minutes for writing + 10 minutes for uploading.

1A. The input $x[n]$ and the impulse response $h[n]$ of an LTI system is given by $x[n] = u[n] - u[n-5]$ and $h[n] = u[n+1] - u[n-10]$. Use convolution sum to evaluate the output $y[n]$ of the LTI system. ***(03)***

1B. A three-phase motor is observed to have a 7th harmonic in the current signal and is defined by $i_7(t) = sin(700\pi t)$. It is sampled at a sampling frequency of 1400 Hz. Find the 8-point DFT of continuous time-signal $i(t)$ using DIF FFT algorithm. Draw the butterfly diagram and show all the values on the diagram. ***(03)***

1C. Consider a cascaded LTI system in which a differentiator and a smoother are present as shown in Figure Q1C. Differentiator and smoother are approximated by the following difference equation.

Differentiator: $w[n] = x[n] - x[n-1]$

Smoother: $y[n] = \frac{y[n-1]}{3} + \frac{w[n]}{3}$

where the output of the differentiator and input the smoother is $w[n]$, while $x[n]$ is the input to the differentiator (also input to the overall system), and $y[n]$ is the output of the smoother (output of the overall system).

(i) Find the overall transfer function of the system. Estimate the location of pole and zero.

(ii) If $x[n] = u[n]$, find the overall system response for the given input.

(iii) If $x[n] = (-1)^n, -\infty < n < \infty$, find the overall system response for the given input. ***(04)***

2A. Calculate a1, a2, c1 and c0 in terms of b1 and b2 so that the two systems shown in Figure Q2A are equivalent. ***(03)***

2B. It is required to optimize the signal-to-noise ratio and sensitivity of a signal receiver application satisfying the linear phase constraint. Achieve it by designing a suitable band-pass filter to pass frequencies in the range $1\ to\ 2$ rad/sample by taking 7 samples of rectangular window sequence. Give the system function and suitable structure to implement the same. Also, plot the frequency response. ***(05)***

2C. For a certain biomedical application, it is required to remove a band of high frequencies and Butterworth filter is used for the same. Determine the order and cut-off frequency of the Butterworth filter using Bilinear transformation technique to meet the following specifications:

$$0.8 \leq \left|H\left(e^{j\omega}\right)\right| \leq 1\ ;\quad 0 \leq \omega \leq 0.2\pi$$

$$\left|H\left(e^{j\omega}\right)\right| \leq 0.2\ ;\quad 0.6\pi \leq \omega \leq \pi$$

Take T = 1 sec. ***(02)***

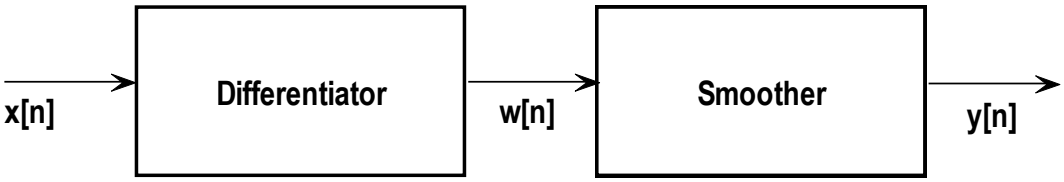

Figure Q1C

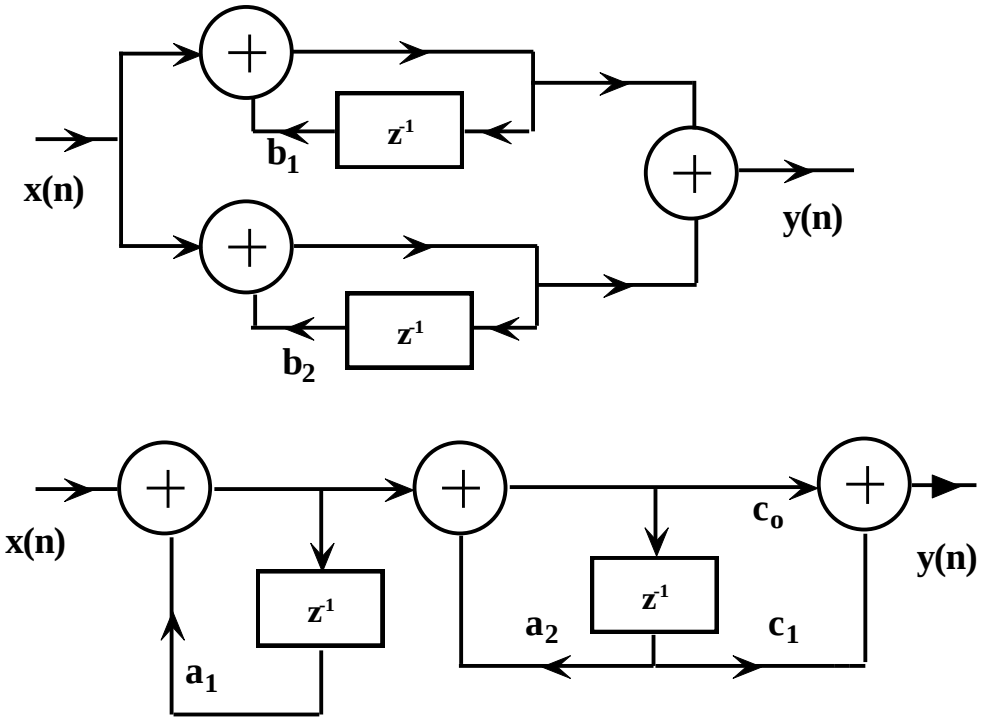

Figure Q2A