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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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V SEMESTER B. TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
MAKE UP EXAMINATIONS, JANUARY 2023

DIGITAL SIGNAL PROCESSING [ELE 3152]
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 06 JANUARY 2023** **Max. Marks: 50**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Use of table of transforms is permitted.

1A. Let $x[n] = \{-0.5, 0.5, 1, \mathbf{1}, 1, 1, 0.5\}$. Find

a. $x(-3-4n)$
b. $x\left(\frac{n-3}{2}\right)$
c. Energy and Power of $x[n]$ **(03)**

1B. For the impulse response $h[n] = e^{2n}u[n-1]$, determine whether the system is

a. Memoryless
b. Causal
c. Stable **(03)**

1C. Evaluate the discrete convolution sum of $x[n] = u[n+10] - 2u[n] + u[n-4]$ and $h[n] = u[n-2]$ **(04)**

2A. Consider a causal LTI system characterized by difference equation

$$y[n] - \frac{3}{4}y[n-1] + \frac{1}{8}y[n-2] = 2x[n]$$

Find $H(z)$ and $h[n]$ **(03)**

2B. If the DTFT of $y[n]$ is $Y(e^{j\omega}) = \frac{d}{d\omega}\left\{e^{-j3\omega}\left[X(e^{j\left(\omega+\frac{\pi}{6}\right)}) - X(e^{j\left(\omega-\frac{\pi}{6}\right)})\right]\right\}$,, find $y[n]$. **(03)**

2C. Two sequences $x_1[n]$ and $x_2[n]$ are given as [2, 3, 4, 1] and [1, 4, 3, 2]. Find the DFT of both the sequences by performing only one 4-point DFT. Use the properties of DFT. **(04)**

3A. The 8-point DFT of a real sequence $y[n]$ is

$Y[k] = [A, \ -14.48j, \ B, \ -2.48j, \ 0, \ C, \ 4j, \ D]$.

Find the value of A, B, C, and D. **(02)**

3B. Find the output $y[n]$ of a filter whose impulse response is $h[n] = [1,\ 1,\ 1]$ and the input signal $x[n] = [3, -1,\ 0,\ 1,\ 3,\ 2,\ 0,\ 1,\ 2]$ using overlap and add method. Take length of data block as 3. **(04)**

3C. Compute the 8-point DFT of discrete-time signal $x[n] = [\mathbf{1},\ 1,\ 1,\ 1, 0,\ 0,\ 0,\ 0]$ using DIT FFT algorithm. Draw the butterfly diagram and show all the values on the diagram. **(04)**

4A. An analog signal $x_a(t) = \sin(350\pi t) + 5sin(540\pi t)$ is sampled at the rate of 450 samples per second. (i) What are the digital frequencies in the resulting discrete-time signal $x[n]$? (ii) If $x[n]$ is passed through an ideal D/A converter what is the reconstructed signal $y_a(t)$? ***(02)***

4B. Design a FIR filter that will reject a very strong 5 Hz sinusoidal interference contaminating a 200 Hz useful sinusoidal signal. Determine the gain of the filter such that the filter does not change the amplitude of the useful signal. Assume sampling frequency of 500 Hz. Draw the pole-zero plot. Suggest a scheme to improve the performance of such filtering. ***(04)***

4C. Design a suitable linear phase FIR filter of order 8 using rectangular widow. The magnitude of the desired frequency response is

$$|H_d[e^{j\omega}]| = \begin{cases} 1; & \omega_{c1} \le |\omega| \le \omega_{c2} \\ 0; & otherwise \end{cases}$$

Let $\omega_{c1} = 1\, rad/sec$ and $\omega_{c2} = 2\, rad/sec$. ***(04)***

5A. Ideal filters are non-realizable filters. Prove or disprove the statement. ***(02)***

5B. List the differences between FIR and IIR filters ***(02)***

5C. Design a Butterworth IIR low-pass filter that satisfies the following conditions:

$$0.75 \le \left|H[e^{j\omega}]\right| \le 1; for\ 0 \le |\omega| \le 0.25\pi$$

$$\left|H[e^{j\omega}]\right| \le 0.23; for\ 0.63\pi \le |\omega| \le \pi$$

Use bi-linear transformation technique. Take sampling frequency of 8 KHz. ***(06)***