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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent Institution of MAHE, Manipal)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2018

SUBJECT: DIGITAL SIGNAL PROCESSING [ELE 3102]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 21 November 2018** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Quick reference table may be supplied

1A. Obtain a 4- point DFT of the sequence, $x[n] = -5\delta[n+2] + 2\delta[n] + \delta[n-1]$
Using Twiddle factor. ***(03)***

1B. Find the IDFT of $Y(k) = |X(k)|^2$ using properties if $X(k)$ is an 8 point DFT of the sequence $x[n] = u[n] - u[n-6]$ ***(04)***

1C. An analog input signal $x_a(t) = \cos(40\pi t) + 0.5\cos(100\pi t) + 2\sin(300\pi t)$ is instantaneously sampled with sampling frequency of 200 samples/sec.

(i) Find the maximum allowable value of T_s.

(ii) Determine the discrete time signal x[n] and mention aliasing if any.

(iii) Obtain the reconstructed signal $y_a(t)$ ***(03)***

2A. If x[n] is a finite length sequence with $X(k) = \{3, 3+j4, -3, 3-j4\}$.Using properties find the DFT of $y_1[n]$ and $y_2[n]$

(i) $y_1[n] = \cos\left(\frac{\pi n}{2}\right) x[n]$

(ii) $y_2[n] = x((n+2))_4$ ***(03)***

2B. Determine the output y(n) of a filter using Overlap save method whose impulse response is $h[n] = -3\delta[n] + \delta[n-1] - \delta[n-2]$ and

input sequence $x[n] = (-2)^n \cos\left(\frac{\pi n}{2}\right)\{u[n] - u[n-8]\}$.Take sub-frame length of 4. ***(03)***

2C. Synthesize the transfer function H(z) using a lattice ladder network. Comment on the stability of the system. Draw the lattice ladder network.

$$H(z) = \frac{1 + z^{-1} + 0.5z^{-2}}{1 + 0.2z^{-1} - 0.15z^{-2}}$$ ***(04)***

3A. Design an FIR digital filter that will reject a very strong 60 Hz sinusoidal interference contaminating a 300 Hz useful sinusoidal signal. Find the system function and gain of the digital system such that the filter does not change the amplitude of the useful signal. Assume sampling frequency Fs=1200 Hz. Also draw the pole zero plot. ***(03)***

3B. Find the eight point DFT of $x(n) = 3\delta(n+2) - 2\delta(n+1) + \delta(n) + 4\delta(n-2) - 3\delta(n-4)$ using Radix-2 DIT FFT algorithm. Draw the DIT FFT butterfly diagram and show the calculation for each stage. ***(04)***

3C. Consider a causal linear time-invariant system whose system function is

$$H(z) = \frac{1 - \frac{1}{5}z^{-1}}{\left(1 - \frac{1}{2}z^{-1} + \frac{1}{3}z^{-2}\right)\left(1 + \frac{1}{4}z^{-1}\right)}$$

Draw the filter structure for implementation of the system using

a. Direct form I
b. Direct form II ***(03)***

4A. Design a 7-tap linear phase FIR digital filter using Hanning window for the following desired frequency response. Also draw the linear phase realization of the filter.

$$\left|H_d\left(e^{j\omega}\right)\right| = \begin{cases} 1; & for\,|\omega| \le \frac{\pi}{4} \\ 0; & for\;\; \frac{\pi}{4} \le |\omega| \le \frac{\pi}{2} \\ 1; & for\;\; \frac{\pi}{2} \le |\omega| \le \pi \end{cases}$$

(05)

4B. Design an ideal low-pass FIR digital filter using frequency sampling method to satisfy the following condition.

Length of filter= 11

Sampling frequency $= 20\ kHz$

Pass-band: $0 \le F \le 5\ kHz$

Also find the transfer function of the filter. ***(05)***

5A. Determine the coefficient of linear phase FIR filter described by difference equation

$y[n] = ax[n] + bx[n-1] + cx[n-2] + \mathrm{d}\,x[n-3] + gx[n-4]$

Given: $\left|He^{j0}\right| = 0.02;\ \left|He^{j0.5\pi}\right| = 0.707;\ \left|He^{j\pi}\right| = 1;$

(04)

5B. Design a Butterworth digital IIR low-pass filter using Bilinear transformation (BLT) technique to satisfy the following specifications:

Sampling frequency: $10^4\ Hz$

$0.8 \le \left|H\left(e^{j\omega}\right)\right| \le 1;\quad for\ 0 \le \omega \le 0.4\pi$

$\left|H\left(e^{j\omega}\right)\right| \le 0.1;\quad for\ 0.8\pi \le \omega \le \pi$

(06)