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MANIPAL INSTITUTE OF TECHNOLOGY
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V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, NOVEMBER 2017
SUBJECT: DIGITAL SIGNAL PROCESSING [ELE 3102]
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 17 November 2017** **Max. Marks: 50**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- DSP-Quick Reference Table can be supplied.

1A. Consider an input signal given by $x_a(t) = 3\cos 2000\pi t + 5\sin 6000\pi t - 10\cos 12000\pi t$. The sampling rate is 5000 samples/sec. (i) Find the folding frequency. (ii) Determine the discrete time signal $x[n]$. Illustrate aliasing if any. (iii) What is the analog signal $y_a(t)$ that can be constructed from the samples using ideal interpolation? ***(04)***

1B. For the given sequence,

$x[n] = -2\delta(n+1) + 2\delta(n) + \delta(n-1) + \delta(n-2)$, find 5- point DFT using Twiddle factor. ***(04)***

1C. The 8-point DFT of a real sequence is $X(k) = \{1, A, -1, B, 0, -j2, C, -1+j\}$. Find A, B and C. ***(02)***

2A. If $x[n] = \delta[n] + 2\delta[n-2] - \delta[n-5]$ has a 6 point DFT X(k), find the inverse DFT of

(i) Re[X(k)] (ii) Im[X(k)] ***(03)***

2B. Determine the output $y[n]$ of a filter using Overlap save method whose impulse response is $h[n] = 2\delta[n] - \delta[n-1] + 2\delta[n-2]$ and input sequence $x[n] = (-1)^n[u(n) - u(n-12)]$, Take sub-frame length of 4. ***(04)***

2C. Sketch pole-zero plot and obtain the respective transfer function of IIR low-pass, high-pass and notch filter using the pole-zero placement technique. ***(03)***

3A. Discuss the reduction in computational complexity of radix-2 FFT algorithm as compared to direct DFT computation. Obtain the time domain sequence $x[n]$ using 8 point Radix-2 DIT-FFT algorithm where the first five DFT coefficients of the real sequence is given as:

$X(k) = \{0, (2\sqrt{2} - j2\sqrt{2}), 0, 0, 0, \ldots\ldots\ldots\}$ ***(04)***

3B. Obtain and draw the direct form I, direct form II and cascade (first order sections) structures for the filter given by the difference equation

$$y(n) = \frac{3}{4}y(n-1) - \frac{1}{8}y(n-2) + x(n) + \frac{1}{3}x(n-1)$$ ***(03)***

3C. Design an FIR digital filter that will reject a very strong 60 Hz sinusoidal interference contaminating a 200Hz 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 Fs = 500Hz. Suggest a scheme to improve the performance of such filtering. ***(03)***

4A. A dynamic of discrete time system is described by the difference equation.

$$y(n)+\frac{3}{4}y(n-1)+\frac{1}{4}y(n-2)=x(n)+2x(n-1)$$

It is required to implement the system on the digital platform. Realize the system using the lattice ladder structure. ***(04)***

4B. A linear phase FIR digital filter is described by non-recursive difference equation,

$y[n]=b_0\,x[n]+b_1\,x[n-1]+b_2\,x[n-2]$. Determine the filter coefficient such that it rejects a frequency component at $\omega_0=\frac{\pi}{3}$ and its frequency response is normalized so that $\left|H\left(e^{j\omega}\right)\right|=1$ at DC frequency. ***(02)***

4C. Given the ideal frequency response of FIR filter shown in Fig.Q4C, determine the following

(i) the order and type of filter (ii) from fundamental the unit impulse response $h_d[n]$ (iii) the filter coefficient $h[n]$. Use Hamming window ***(04)***

5A. Show that the relation between analog and digital frequency with reference to bilinear transformation is nonlinear and it results in frequency compression. ***(02)***

5B. Design an ideal low-pass FIR digital filter using frequency sampling method to satisfy the following conditions.

Length of filter: 9

Sampling frequency: 20 kHz

Passband: $0 \le \mathrm{F} \le 5\,\mathrm{kHz}$ ***(04)***

5C. Design a digital low-pass Butterworth filter using Bilinear transformation to meet the following specifications.

$$0.8414 \le \left|\left(He^{j\omega}\right)\right| \le 1 \quad ; 0 \le \omega \le \frac{\pi}{3}$$

$$\left|H\left(e^{j\omega}\right)\right| \le 0.3162 \quad ; \frac{\pi}{2} \le \omega \le \pi$$

Take $\mathrm{T}=1\mathrm{sec}$ ***(04)***

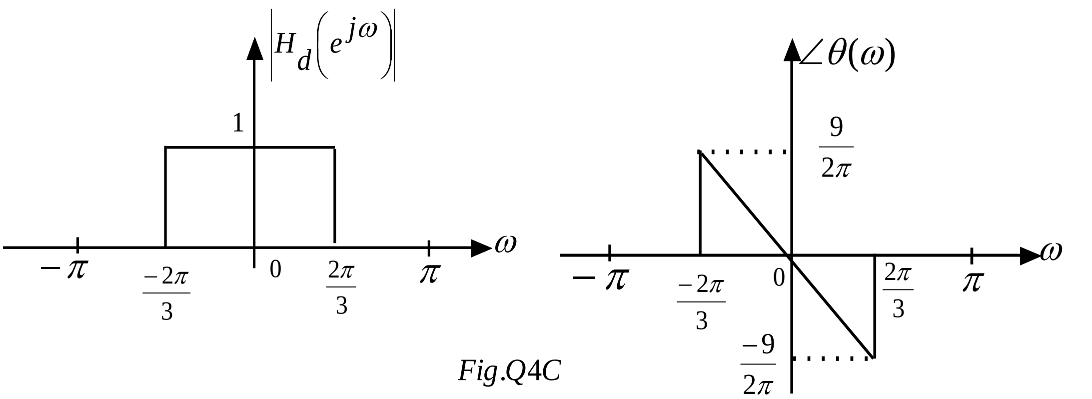

Fig.Q4C