sem VII / R&W / e&tl / D.T.S.P / Dec.09

Con. 5475–09. **SP–6635**

(3 Hours) **[Total Marks : 100**

N. B. (1) Question No.1 is compulsory.
(2) Attempt any four questions out of remaining six questions.
(3) Assume suitable data if required.

1. (a) Determine the coefficients $\{h(n)\}$ of a highpass linear phase FIR filter of length $M = 4$ which an antisymmetric unit sample response $h(n)$ and a frequency response that satisfies the condition

$$\left|H\left(\frac{\pi}{4}\right)\right| = \frac{1}{2}, \quad \left|H\left(\frac{3\pi}{4}\right)\right| = 1$$

(b) Obtain the mapping formula for the bilinear transformation method.
(c) How may we compute the N-point DFT of two real valued sequences, $x_1(n)$ and $x_2(n)$ using one N-point DFT?
(d) Compare Analog and Digital filters. (20)

2. (a) Justify that the spectrum of an aperiodic discrete time signal with finite duration L, can be recovered from its samples at frequencies $\omega_k = \frac{2\pi k}{N}$, if $N \geq L$. Where N is the number of frequency samples in frequency domain and $k = 0, 1, 2, \ldots, N-1$ (8)
(b) Design a digital resonator with a peak gain of unity at 50 Hz and 3dB bandwidth of 6Hz assuming a sampling frequency of 300Hz. (6)
(c) Realize a coupled form oscillator (two sinusoidal carrier signals in phase quadrature) with the help of block diagram. (6)

3. (a) Find DFT of
(i) $x(N) = \{1, 1, 1, 1\}$ (4)
(ii) $x(N) = \{1, 0, 1, 0, 1, 0, 1, 0\}$ (3)
(iii) $x(N) = \{1, 1, 1, 1, 1, 1, 1, 1\}$ (3)
(b) Explain the Frequency Sampling method of designing an FIR filter. (10)

4. (a) What is DCT ? Explain how DCT is classified in four types as DCT-I, DCT-II, DCT-III and DCT-IV. Which type is mostly used and why? (10)
(b) Design a digital Butterworth filter to satisfy the constraints, (10)

$$\sqrt{0.5} \leq \left|H\left(e^{j\omega}\right)\right| \leq 1, \qquad 0 \leq \omega \leq \pi/2$$

$$\left|H\left(e^{j\omega}\right)\right| \leq 0.2, \qquad \frac{3\pi}{4} \leq \omega \leq \pi$$

With $T = 1\text{sec}$. Apply impulse invariant transformation.

5. (a) Given $x(n) = n + 1$ and $N = 8$ Find DFT $X(k)$, using DIF FFT algorithm. (10)
(b) Obtain the direct form-I and direct form-II realization for the second order filter given by (10)

$$y(n) = 2b\cos\omega_0 y(n-1) - b^2 y(n-2) + x(n) - b\cos\omega_0 x(n-1)$$

6. (a) Design low pass FIR filter to satisfy following specifications (10)

$$H_d\left(e^{j\omega}\right) = \begin{cases} e^{-j2\omega}, & -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4} \\ 0, & \frac{\pi}{4} \leq \omega \leq \pi \end{cases}$$

Determine the filter coefficients $h_d(n)$ if the window function is defined as

$$w(n) = \begin{cases} 1, & 0 \leq n \leq 4 \\ 0, & otherwise \end{cases}$$

Also, determine the frequency response $H\left(e^{j\omega}\right)$ of the designed filter.
(b) Compare the DSP processors and general purpose processors. (10)

7. Write short notes on the following :
(a) TMS 32 C 5X series of processors (7)
(b) Finite word length effects in digital filters (7)
(c) Applications of DCT (6)