M.E. Sem I (Rev.) Etrx. Discrete Time Signal Processing & Applications 01/12/08

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Con. 5181–08. **(REVISED COURSE)** **BB–8202**

(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 **necessary**.
(4) **Figures** to the **right** indicate **full** marks.

1. (a) Check whether the following filter is a Linear phase filter or not. If yes, draw the phase response to prove it. **5**
Given $H(z) = 1 - z^{-1} + z^{-3} - z^{-4}$.
(b) State whether the following statement is true or false. Justify your answer. **5**
Anti symmetrical FIR filters are not suitable to design linear phase low pass FIR filters.
(c) Write a difference equation for a system which generates a sequence **5**
$y(n) = (0{\cdot}2)^n \text{ Sin } {}^{\pi}/_6 \, n \, u(n)$
(d) Develop the relationship between DTFT and DFT, ZT and DFT of discrete time signal x(n) **5**

2. (a) A descrete time system is described by the equation $y(n) = x(n) - y(n-1) + 6y(n-1)$ **10**
The input to the system is $x(n) = 8u(n)$ with initial conditions $y(-1) = 1$ and $y(-2) = -1$. Determine :
(i) Zero input response
(ii) Zero state response
(iii) Total response.
(b) Draw DITFFT flow graph for N = 6 (composite FFT). Derive the necessary equations to obtain composite FFT. **10**

3. (a) Show cascade and parallel realization of the following causal LTI systems using real coefficients only **10**

$$H(z) = \frac{10z\left(z - \frac{1}{2}\right)\left(z - \frac{2}{3}\right)(z + 2)}{\left(z - \frac{3}{4}\right)\left(z - \frac{1}{8}\right)\left(z - \frac{1}{2} - j\frac{1}{2}\right)\left(z - \frac{1}{2} + j\frac{1}{2}\right)}$$

(b) The cut off frequency of a LPF is required to be 100 Hz. Sampling frequency is 1 kHz. Design a second order Butterworth filter using **10**
(i) Bilinear Transformation method
(ii) Impulse Invariant method.

4. (a) (i) Impulse Invariant method is not suitable for HPF/BPF design. Justify. **5**
(ii) A linear filter having frequency response as $H(e^{jw}) = e^{-2jw}[2 \sin 2w + 5 \sin w]$. **5**
Show pole – zero diagram of the filter.
(b) Let x(n) = {1, 2, 3, 4} and y(n) = {5, 6, 7, 8}. Find DFT of each of the sequence using 4 point FFT only once. **10**

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5. (a) Given $y(n) = ay(n-1) + bx(n) \quad 0 < a < 1$ **10**

(i) Determine the magnitude and phase response $H(w)$ of the filter.

(ii) Choose the parameter 'b' so that magnitude value of $|H(w)|$ is unity and sketch $|H(w)|$ and $< H(w)$ for $a = 0{\cdot}9$.

(iii) Determine the o/p of the filter to the input signal $x(n) = 5 + 12 \sin(n^{\pi}/2) - 20 \cos(n\pi + {}^{\pi}/4)$

(b) (i) If $x(n) = \{1, 2, 3, 1, 4, 1, 3, 2\}$. Find $x(k)$ using DITFFT algorithm. **10**

(ii) Using result in (i) only find $x2(k)$ if $x_2(n) = x(-n)$.

6. (a) Design a sixth order, linear phase FIR filter using frequency sampling technique. The DFT $H(k)$ of impulse response function is given below. $H(0) = 1$, $H(1) = e^{-j6\pi/7}$, $H(6) = e^{+j6\pi/7}$. $H(2) = H(3) = h(4) = H(5) = 0$. Draw realisation diagram with real coefficients only. **10**

(b) A system transfer of a causal LTI system is given as **10**

$$H(z) = \frac{z^2 + 0{\cdot}25}{z^2 - 0{\cdot}4z - 0{\cdot}05}$$

(i) Draw pole – zero diagram of the system and indicate whether system is minimum phase or maximum phase type. Justify your answer.

(ii) For this system to be stable, what may be the ROC of the system. Write difference equation of the system.

(iii) Find impulse response of the system.

(iv) Give difference equation and corresponding realisation diagram if the system equation is realised using (1) Direct Form II, (2) Cascade Form of realisation.

7. A filter is required to be designed with the following response **20**

$$Hd(e^{jw}) = \begin{cases} 2e^{-j2w} & -\frac{\pi}{4} \le w \le \frac{\pi}{4} \\ 0 & \frac{\pi}{4} \le |w| \le \pi \end{cases}$$

(a) Determine the filter coefficients if rectangular window function is used for design.

(b) Determine the frequency response $H(e^{jw})$ of the designed filter.

(c) Show realization of the filter with minimum number of multiplications.

(d) Find the response of the filter to the input :

(i) $x(n) = \left(\frac{1}{2}\right)^n \cos\left(n\frac{\pi}{3}\right) u(n)$

(ii) $x(n) = \left(\frac{1}{2}\right)^n \cos\left(n\frac{\pi}{3}\right)$
