BE Sem. VII (Rev) ETRx Filter Theory & Applications 19/5/05

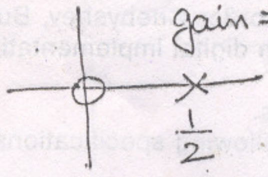
346 : D-viiMyp65

Con. 2347-05. (REVISED COURSE) AM-8432

(3 Hours) [Total Marks : 100

N.B. (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** out of remaining **six** questions.
(3) Assumptions made should be **clearly** stated.
(4) Assume **suitable** data wherever **required** but justify the **same.**

1. (a) A digital filter has pole zero location as shown : 20



Find steadystate response of system to input $x(n) = 10 \cos (\pi/2n + \pi/3)$.

(b) Show that zeros of a linear phase FIR filter occur at reciprocal locations and FIR filters of symmetric impulse response. Coefficients and even length will compulsorily have a zero at $z = -1$.

(c) Compare IIR and FIR filters.

(d) Show direct form realization of digital resonator.

2. (a) A digital filter has a zero at origin and a pole at 'a', $0 < a < 1$. If due to parameter quantization pole shifts to location 'b' where $b < a$ and $0 < b < 1$. What is effect on magnitude response at $w = 0$ and $w = \pi$. 10

(b) A first order system is described by — 10

$$y(n) = ay(n-1) + x(n)$$

Assume that all variables and coefficients are represented in sign magnitude form with results of multiplications truncated before additions are performed Non-linear difference equation implemented is —

$$\hat{y}(n) = Q[a\,\hat{y}(n-1)] + x(n)$$

Where $Q(\cdot)$ represents sign magnitude truncation zero input limit cycle is of the form.

$$|\hat{y}(n)| = |\hat{y}(n-1)| \quad \text{for all n.}$$

Show that if ideal system is stable, then no zero input limit cycle can exist.

3. (a) Convert $H(s) = \dfrac{4}{(s+1)(s^2+4s+5)}$ to H(z) using impulse invariance with ts = 0·5 sec. 10

(b) Explain matched z-transform technique. Convert $H(s) = \dfrac{4}{(s+1)(s+2)}$ to H(z) by matched z-transform and its modifications with ts = 0·5 sec.

4. (a) Design a low pass filter with cut off frequency of 5 kHz and sampling frequency of 20 kHz using a Bartlett window. 10

$$w = 1 - \frac{2|n|}{N-1}, \quad -4, \leq n \leq 4.$$

(b) Discuss in detail the design procedure of optimal linear phase FIR filter. 10

5. (a) Convert the single pole low pass Butterworth filter with system function — 10

$$H(z) = \frac{0 \cdot 245\left(1+z^{-1}\right)}{1-0 \cdot 509z^{-1}}$$

into a bandpass filter with upper and lower cut off frequencies of wu and wt respectively. The low pass filter has 3-dB bandwidth of $w_p = 0{\cdot}2\,\pi$.

(b) A causal IIR filter has transfer function of —

$$H(z) = \frac{1+2z^{-1}+3z^{-2}+2z^{-3}}{1+0 \cdot 9z^{-1}-0 \cdot 8z^{-2}+0 \cdot 5z^{-3}}$$

Determine the equivalent lattice structure.

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6. (a) Determine coefficients of linear phase FIR filter of length M = 15 which has symmetric impulse response and frequency response that satisfies the condition — **10**

$$H_r\left(\frac{2\pi k}{15}\right) = \begin{cases} 1 & k = 0, 1, 2, 3 \\ 0 & k = 4, 5, 6, 7 \end{cases}$$

(b) A digital low pass filter is required to meet following specifications :— **10**

Passband ripple $\leq$ 1 dB   Stopband attenuation $\geq$ 40 dB
Passband Edge 4 kHz   Stopband Edge : 6 kHz
Sample rate : 24 kHz.

Using Bilinear transformation determine what order Chebyshev, Butterworth and elliptic analog designs must be used to meet specifications in digital implementation.

7. (a) Discuss the design procedure of Bessel Filters. **10**

(b) Design an elliptic low pass filter to meet the following specifications : **10**

A_p = 2 dB W_p = 4 rad/s
A_s = 20 dB W_s = 8 rad/s