B.E/ETRX/Sem VII
Filter Theory & Applications

Con. 5162-09. SP-6548

(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 whenever **necessary** and **justify** it.

1. (a) Explain warping effect in bilinear transformation. Draw a neat sketch to show it. How it can be avoided while designing a filter. **20**
(b) Compare rectangular Window and Hamming window with respect to main lobe and side lobes.
(c) An antisymmetric Linear phase FIR filter of any order always has a zero at ' +1'. State true or false and justify.
(d) State true or false and justify. The poles of the butterworth filter lie on a circle whereas the poles of the Chebyshev filter lie on an ellipse.
(e) The analog poles will not be aliased by the impulse invariant mapping if they are confined to the s-plane's primary strip. State true or false and justify.

2. Using bilinear transformation design a Digital bandpass Chebyshev filter with the following specification : **20**
α_p = 2 dB in the passband, (950 Hz) $\leq$ f $\leq$ (1150 Hz)
α_s = 20 dB in the stopband, 0 $\leq$ f $\leq$ (550 Hz) and (2150 Hz) $\leq$ f $\leq \infty$
Sampling Frequency f = 8 KHz

3. (a) Convert the single Pole Low Pass filter with system function **12**

$$H(z) = \frac{0{\cdot}45\left(1+z^{-1}\right)}{1-0{\cdot}25z^{-2}}$$

into bandpass filter with upper and lower cutoff frequency W_u and W_l respectively. The L.P. filter has a 3 dB bandwith of W_p = 0·5 and W_u = 2·5, Wl = 0·8.
(b) Show that the relation between Analog frequency and Digital frequency in bilinear transformation is given by— **8**

$$\Omega = \frac{2}{T}\tan\left(\frac{w}{2}\right)$$

using relation between 'S' and 'Z' in bilinear transformation.

4. (a) A digital filter is required to meet following specifications : **12**

$$0{\cdot}75 \leq |H(ejw)| \leq 1 \text{ for } \frac{3\pi}{4} \leq w \leq \pi$$

$$|H(ejw)| \leq 0{\cdot}2 \text{ for } 0 \leq w \leq \pi/2$$

Find order of the corresponding Low Pass Prototype if—
(i) Butterworth filter is to be design using BLT
(ii) Chebyshev filter is to be design using BLT
(iii) Butterworth filter is to be design using IIM
(iv) Cheyshev filter is to be design using IIM
(b) Find the T.F. of a third order analog Butterworth filter and convert it into Digital filter using impulse invariant method (IIM). **8**
Assume sampling interval T = 1 sec.

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5. (a) Convert the following pole-zero IIR filter into a lattice-ladder structure — 12

$$y(n) = -0{\cdot}9y(n-1) + 0{\cdot}8y(n-2) - 0{\cdot}5y(n-3) + x(n) + 2x(n-1) + 3x(n-2) + 2x(n-3)$$

(b) For a fourth order Linear phase FIR filter with odd symmetry in coefficients, one of the zero is at $r\,e^{\pm j\pi/3}$ choose suitable value of r and find— 8

(i) Plole-zero diagram

(ii) Impulse response of the filter.

6. (a) Design a FIR filter with following desired response 14

$$H_d(ejw) = 0, \quad |w| \leq \pi/4$$

$$= e^{-j3w}, \quad \frac{\pi}{4} \leq |w| \leq \pi$$

Using (i) Bartlett window

(ii) Blackman window.

Compare their magnitude response.

(b) A four bit processor is used to implement a digital filter with a difference equation 6

$$y(n) = x(n) - 0{\cdot}57y(n-1) - 0{\cdot}081y(n-2).$$

If one bit is used as a sign bit and rounding method is used during quantization find out shift of poles from their original place when—

(i) DF II is used for filter realization

(ii) Cascade form is used for filter realization.

7. Write short notes on any **three** of the following :— 20

(a) Frequency sampling technique for FIR filter design

(b) Design procedure for FIR filter design using Kaiser window.

(c) Discuss design procedure for elliptic filter

(d) Explain Quantization limit cycles for first order and second order filters.
