Department of Communications and Computer Engineering

CCE5201-Advanced Signal Processing

Tutorial 1

1. Design a linear phase filter, calculating the necessary order using Kaiser's formula, that satisfies the following conditions based on

   (a) a single stage structure (b) a two stage multirate strucutre

Sampling Rate	10,000 Hz	Passband	$0 \le F \le 60$
Transition Band	$60 \le F \le 65$	Ripple	$\delta_1 = 10^{-1}$; $\delta_2 = 10^{-3}$.

2. Sketch the structure of a system with a rate change of 2.5, that uses an impulse function of 30 coefficients using

   (i) direct FIR filter with suitable decimation and interpolation

   (ii) a polyphase structure that reduces the number of multiplications.

3. (Proakis and Monolakis 11.11). Consider an arbitrary digital filter with transfer

   function $$H(z) = \sum_{n=-\infty}^{n=+\infty} h(n)\, z^{-n}$$

   (a) Perform a two component polyphase decomposition of H(z) by grouping the even-numbered samples $h_0(n) = h(2n)$ and the odd numbered samples $h_1(n) = h(2n+1)$. Show that H(z) can be expressed as

   $H(z) = H_0(z^2) + z^{-1} H_1(z^2)$ and determine $H_0(z)$ and $H_1(z)$.

   (b) Generalize the result in part (a) by showing that H(z) can be decomposed into a D-component polyphase filter structure with transfer function

   $H(z) = \sum_{k=0}^{D-1} z^{-k} H_k(z^D)$ and determine $H_k(z)$

   (c) For the IIR filter with transfer function

   $H(z) = \frac{1}{1 - az^{-1}}$ determine $H_0(z)$ and $H_1(z)$ for

   the two component decomposition.

4. Proakis and Monolakis 11 . 1