Indian Institute of Technology, Kharagpur
Department of Electronics and Electrical Communication Engineering
Digital Signal Processing (EC31008)
End-Spring Semester Examination, 2011
Date of Examination: 28th April, 2010 (AN)
Full Marks: 100
Time: 3 hours

1(a) An FIR filter $H(z)$ is realized as a cascade of two filters $H_1(z)=1-2z^{-1}+2.5z^{-2}$ and $H_2(z)$. Determine $H_2(z)$ to make the resulting filter linear phase of minimum order.
(b) Determine the magnitude and the phase response of $H(z)$ and sketch those.
(c) Show the realization of the filter using minimum number of multipliers and derive its transpose structure. (5+5+5)

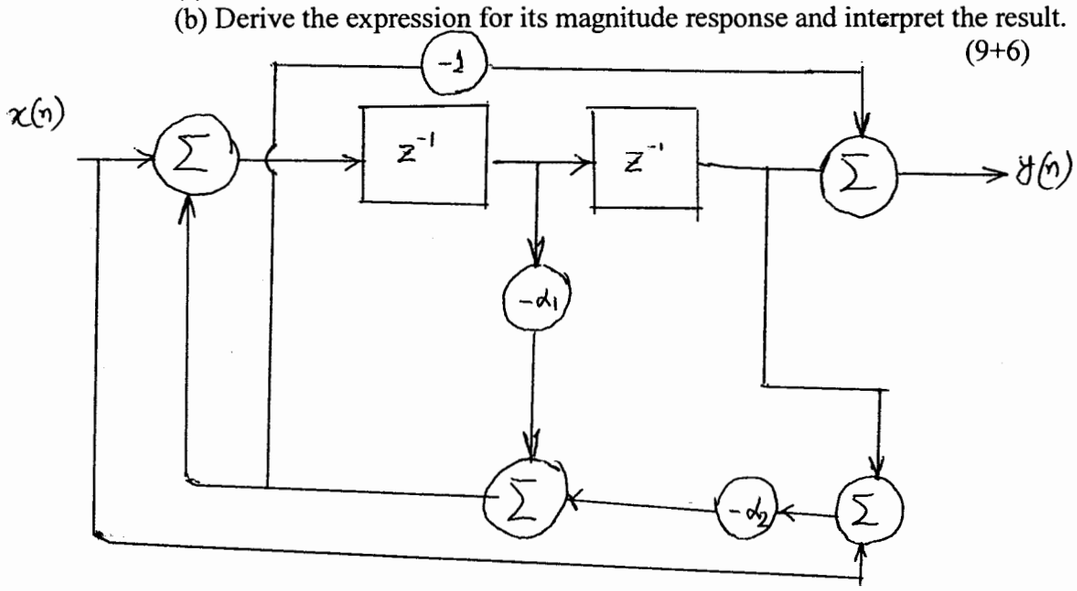
2(a) Examine analytically if all the roots of the following polynomials are lying within the unit circle:
$D(z)=10+8z^{-1}+5z^{-2}+3z^{-3}+2z^{-4}+z^{-5}$
(b) Show that the following band-pass and band-stop filters are doubly complementary

$$H_{BP}(z)=\frac{1-\alpha}{2}\cdot\frac{1-z^{-2}}{1-\beta(1+\alpha)z^{-1}+\alpha z^{-2}}$$

$$H_{BS}(z)=\frac{1+\alpha}{2}\cdot\frac{1-2\beta z^{-1}+z^{-2}}{1-\beta(1+\alpha)z^{-1}+\alpha z^{-2}}$$

(c) Show how an all-pass filter can be used to implement both the filters. ((9+6+5)

3. Given the realization depicted in the figure shown below:
(a) Determine its transfer function
(b) Derive the expression for its magnitude response and interpret the result.
(9+6)



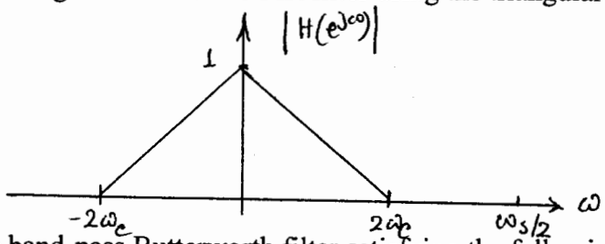
4. Design a digital high-pass Chebyshev filter with the following specifications:

- 0.5 dB ripple on the pass-band at the edge frequency of 3000 Hz
- 25-dB attenuation at the stop-band edge frequency of 1000 Hz
- Sampling frequency of 8000 Hz (15)

5. For the magnitude response shown in the figure below, where $\omega = 2\pi$ denotes its sampling frequency:

(a) Determine the ideal impulse response associated with it.

(b) Design a fourth order FIR filter using the triangular window with $\omega_c = \frac{\pi}{4}$ (8+7)



6. Design a band-pass Butterworth filter satisfying the following specifications:

- Pass-band ripple 0.5 dB
- Stop-band rejection better than 60-dB
- $\Omega_{s1} = 40\,\text{Hz}$
- $\Omega_{p1} = 50\,\text{Hz}$
- $\Omega_{p2} = 70\,\text{Hz}$
- $\Omega_{s2} = 80\ \text{Hz}$

(20)