EEL 731 Major/SCDR/05 April 2010
Full marks=50 ; Time allowed=120 minutes

1. **Express an ideal linear phase band-pass filter frequency response with cutoffs at ω_1 and ω_2, $0< \omega_1 < \omega_2 < \pi$, as a combination of those of ideal all-pass, low-pass and high-pass filters. *Hence* find the impulse response of the band-pass filter.[10]**

2. **Using only digital to digital frequency transformation, transform the high-pass filter**
$$H_1(z)=[(1+\alpha)/2](1-z^{-1})/(1-\alpha z^{-1})$$
into a low-pass filter with the same cutoff frequency as that of the high-pass filter.[15]

3. **Using *only* the stability triangle, determine the condition(s) for stability of the transfer function**
$$H_2(z)=(a_0+a_1 z^{-1}+0.8 z^{-2})/(1+b_1 z^{-1}+0.8 z^{-2})$$
For a stable $H_2(z)$, find the range(s) of b_1 for the poles to be (a) real and (b) complex. [10]

4. **Find a realization of the transfer function**
$$H_2(z)=(a_0+a_1 z^{-1}+0.8 z^{-2})/(1+b_1 z^{-1}+0.8 z^{-2})$$
using the new feedback method. [15]

5. **Find, by the SCDR method, a lattice realization of the all-pass transfer function**
$$A_2(z)=[\alpha-\beta(1+\alpha)z^{-1}+z^{-2}]/[\alpha z^{-2}-\beta(1+\alpha)z^{-1}+1]$$ **.[15]**

6. **Is the transfer function**
$$H_4(z)=1+2z^{-1}+3z^{-2}-2z^{-3}-z^{-4}$$
linear phase ? Justify your answer. Give a lattice realization of the transfer function by the SCDR method.[10]

7. **A normalized *Chebyshev* analog low-pass filter of order 2 with ripple parameter ϵ is transformed into another analog filter by the transformation**
$$S=s(s^2+\Omega_0^2)/[(s^2+\Omega_1^2)(s^2+\Omega_2^2)],\ 0<\Omega_1<\Omega_0<\Omega_2<\pi$$
Give a rough sketch of the magnitude response of the new filter.[15]

8. **The two-pair inside the box shown below is the first lattice section obtained in the answer to Q.5. Write the equations for Y_1 and Y_2 in terms of X_1 and X_2 .Rewrite these equations in terms of X_1 , $z^{-1}X_2$, and $W=\alpha(X_1 - z^{-1}X_2)$ only. By drawing the resulting realization, show that the total realization you obtained (hopefully correctly !) in your answer to Q. 5 can be made canonic.[10]**