

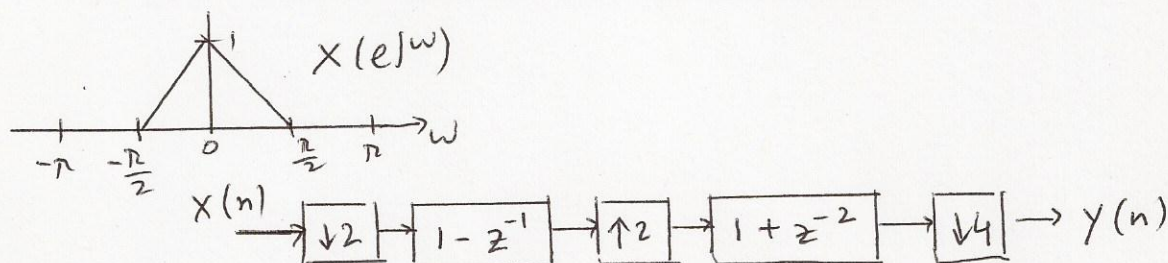
Midterm Exam — ECE 251C Fall 2013, Nguyen

**Problem 1.** (30pt) Consider the following LTI system  $H(z)$  with input-output relation:

$$2y(n) = 2x(n) - 2x(n-1) - 5y(n-1) - 2y(n-2)$$

- Find the two polyphases  $H_{\text{even}}(z)$  and  $H_{\text{odd}}(z)$ , i.e.,  $H(z) = H_{\text{even}}(z^2) + z^{-1}H_{\text{odd}}(z^2)$
- Find the four polyphases  $E_0(z), E_1(z), E_2(z), E_3(z)$ , i.e.,  $H(z) = E_0(z^4) + z^{-1}E_1(z^4) + z^{-2}E_2(z^4) + z^{-3}E_3(z^4)$

**Problem 2.** (30pt) Consider the following multirate system:



- Find  $Y(z)$  in terms of  $X(z)$
- Sketch  $|Y(e^{j\omega})|$

**Problem 3.** (40pt) Consider a FIR PR two-channel filter bank with real-coefficients analysis filters  $H_0(z), H_1(z)$  and synthesis filters  $F_0(z), F_1(z)$ . All filters have length  $N$ . Find all possible orthogonal and linear-phase solutions.