a) A proposed other implementation for the system is shown in Fig. (c). The three impulse responses $h_1[n]$, $h_2[n]$, and $h_3[n]$ are all restricted to be zero outside the range $0 \leq n \leq 2$. Determine and clearly justify a choice for $h_1[n]$, $h_2[n]$, and $h_3[n]$ so that $y_1[n] = y_2[n]$ for any $x[n]$ and all n, i.e., so that the two systems are equivalent.

b) Determine the number of multiplications per output sample required in the system of Fig. (b) and in the system of Fig. (c). Which system is more efficient?

3. (9p) Suppose that you can use Matlab's `firpm` or a similar function to design linear phase FIR filter $H(z)$. Based on $H(z)$, explain how you can design

- Linear-phase half-band filter
- Power symmetric filter
- Low-pass filter with narrow passband and transition band but low number of coefficients

4. (9p) Consider the product filter given by

MISPRINT (NO z SHOULD BE HERE)

$$P(z) = (1 + z^{-1})^2(1 + z)^2(az + bz + az^{-1})$$

- Determine the coefficients a and b such that the result quadrature mirror filter (QMF) bank is perfect reconstructing.
- Enumerate the different ways to factorize the resulting $P(z)$ to get biorthogonal QMF bank
- How do you factorize $P(z)$ to get orthogonal QMF bank?