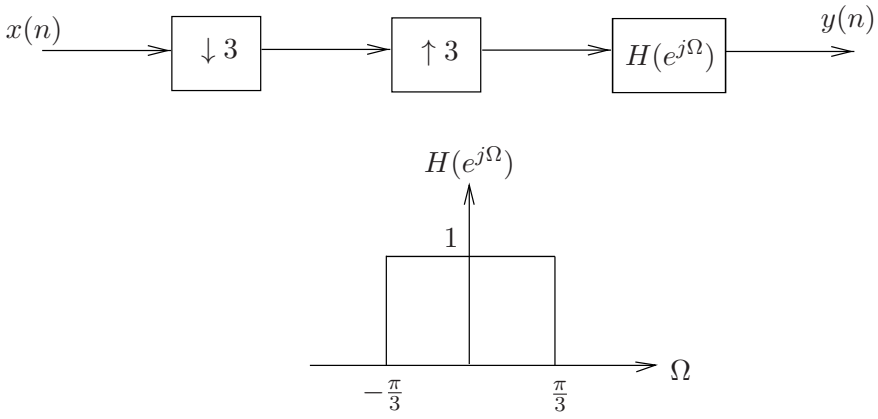
Problem 16 (multirate digital signal processing)

Consider the system shown in the figure. For each of the following input signals $x(n)$, indicate whether the output $y(n) = x(n)$.

(a) $x(n) = cos(\pi n/4)$

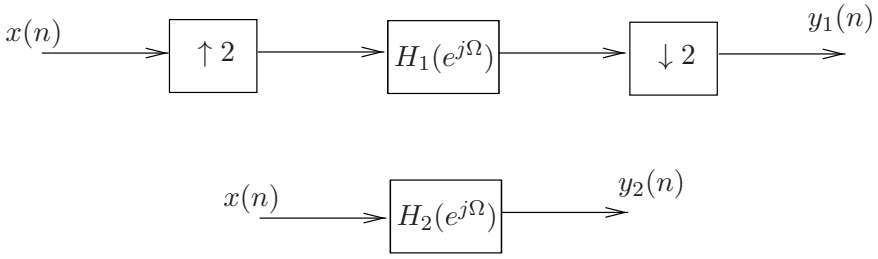
(b) $x(n) = cos(\pi n/2)$

(c) $x(n) = (\frac{sin(\pi n/8)}{\pi n})^2$



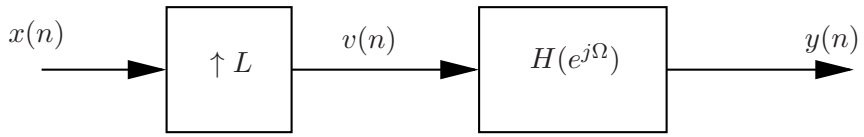
Problem 17 (multirate digital signal processing)

Consider the systems shown in the figure. Suppose that $H_1(e^{j\Omega})$ is fixed and known. Find $H_2(e^{j\Omega})$, the frequency response of an LTI system, such that $y_2(n) = y_1(n)$, if the inputs to the systems are the same.



Problem 18 (multirate digital signal processing)

The system shown in the figure approximately interpolates the sequence $x(n)$ by a factor L. Suppose that the linear filter has impulse response $h(n)$ such that $h(n) = h(-n)$ and $h(n) = 0$ for $|k| > RL - 1$, where R and L are integers; i.e., the impulse response is symmetric and of length $2RL - 1$ samples.



(a) In answering the following, do not be concerned about causality of the system; it can be made causal by including some delay. Specifically, how much delay must be inserted to make the system causal?

(b) What conditions must be satisfied by $h(n)$ in order that $y(n) = x(n/L)$ for $n = 0, \pm L, \pm 2L, \pm 3L, \ldots$?

(c) By exploiting the symmetry of the impulse response, show that each sample of $y(n)$ can be computed with no more than RL multiplications.

(d) By taking advantage of the fact that multiplications by zero need not to be done, show that only $2R$ multiplications per output sample are required.

Problem 19 (multirate digital signal processing)

Consider the noninteger sampling rate conversion in the figure. Develope step by step an efficient structure for the sampling rate conversion, where most calculations are done in the lowest possible sampling rate.