8000152 INTRODUCTORY SIGNAL PROCESSING

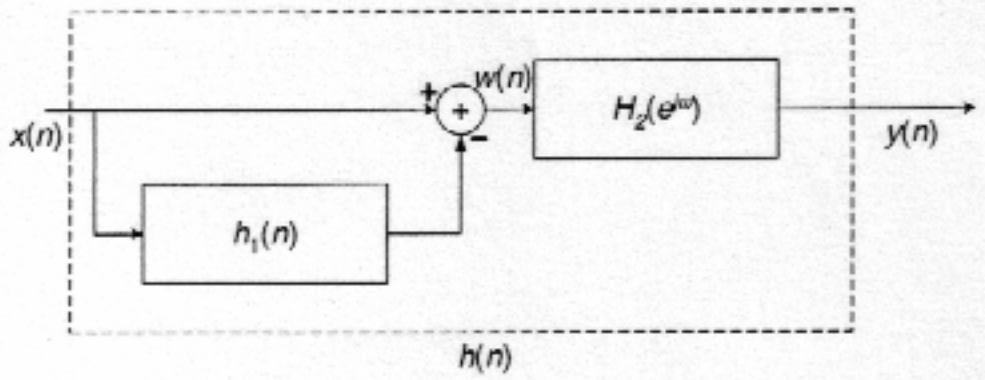
Exam

March 2003

Instructions: Write your name on **every** page in CAPITAL LETTERS and your student number as well. Number pages consecutively. Please, be clean.

Note: You have to solve six problems. Maximum total grade is 30 points.

1. (5 points) Consider the following interconnection of linear shift-invariant systems:

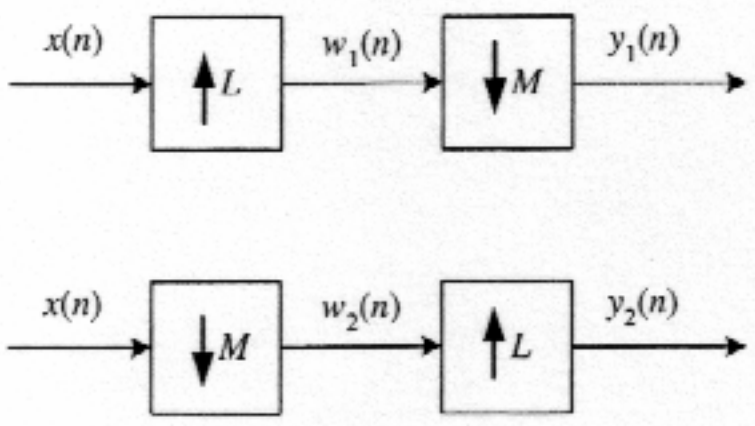


where $h_1(n) = \delta(n-1)$ and $H_2(e^{j\omega}) = \begin{cases} 1 & |\omega| \le \dfrac{\pi}{4} \\ 0 & \dfrac{\pi}{4} < |\omega| \le \pi \end{cases}$

Find the frequency response (2 points) and the impulse response (3 points) of this system.

2. (4 points) A continuous-time signal $x_a(t)$ is to be filtered to remove frequency components in the range 5 kHz $\le f \le$ 15 kHz. The maximum frequency present in $x_a(t)$ is 20 kHz. The filtering is to be done by sampling $x_a(t)$, filtering the sampled signal, and reconstructing an analog signal using an ideal D/C converter. Find the minimum sampling frequency that may be used to avoid aliasing, and for this minimum sampling rate, find and sketch the frequency response of the ideal digital filter $H(e^{j\omega})$ that will remove the desired frequencies from $x_a(t)$.

3. (5 points) Shown in the figure below are two different ways of cascading an up-sampler with a down-sampler.



(a) (2 points) If $M = L$, show that the two systems are not identical.
(b) (3 points) Under what conditions will the two systems be identical?