# SGN-1106 INTRODUCTORY SIGNAL PROCESSING

**Exam**

October 2005

*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 system defined by the difference equation

$$y(n) = ay(n-1) + bx(n) + x(n-1)$$

where $a$ and $b$ are real, and $|a| < 1$.

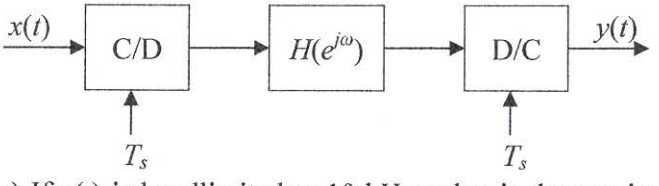
(a) (3 points) Find the relationship between $a$ and $b$ that must exist if the frequency response is to have a constant magnitude for all $\omega$, that is,

$$|H(e^{j\omega})| = 1$$

(b) (2 points) Assuming that this relationship is satisfied, find the output of the system when $a = \frac{1}{2}$ and

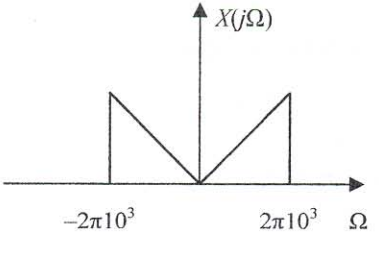
$$x(n) = \left(\frac{1}{2}\right)^n u(n)$$

**2.** (5 points) Consider the system shown in the figure below.

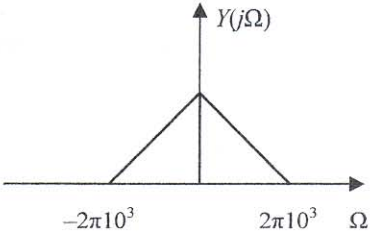



(a) (2 points) If $x(t)$ is bandlimited to 10 kHz, what is the maximum value of the sampling period $T_s$ that can be used to avoid aliasing?

(b) (3 points) Given the Fourier transform of $x(n)$ is as shown on figure (a) below, it is desired to obtain $y(n)$ with Fourier transform as shown on figure (b). Specify the impulse response $h(n)$ of the discrete-time system $H(e^{j\omega})$ (Hint: use the frequency shift property of the Fourier transform)




(a)




(b)