類組：電機類　科目：訊號與系統(300B)　

※請在答案卷內作答

一、(5%) Given $x(t)$, plot $y(t) = -2x(t) + 3$ and $y(t) = x(2t) + 1$

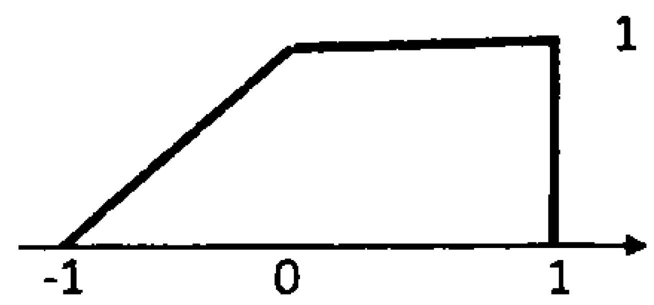


Figure 1. $x(t)$

二、(10%)

(a) (5%) Consider an LTI system with input and output related through the equation:

$$y(t) = \int_{-\infty}^{t} e^{\tau - t} x(\tau - 1) d\tau$$

The impulse response $h(t)$ for this system = ________. Is the system causal? ________ (simply answer yes or no)

(b) (5%) Consider the cascade interconnection of three causal LTI systems, illustrated in Figure 2(a). The impulse response $h_2[n]$ is $\delta[n]$ - $\delta[n\text{-}2]$. The overall impulse response of the cascaded system is shown in Figure 2(b). What is the value of $\boldsymbol{h_1[0] + h_1[1]}$? Ans: ________________

You need to write down your answers only. No partial scores for your computation procedures.

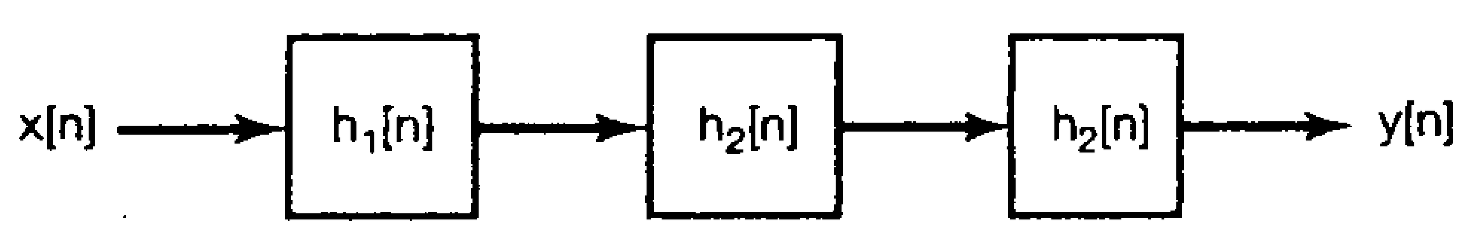


Figure 2(a)

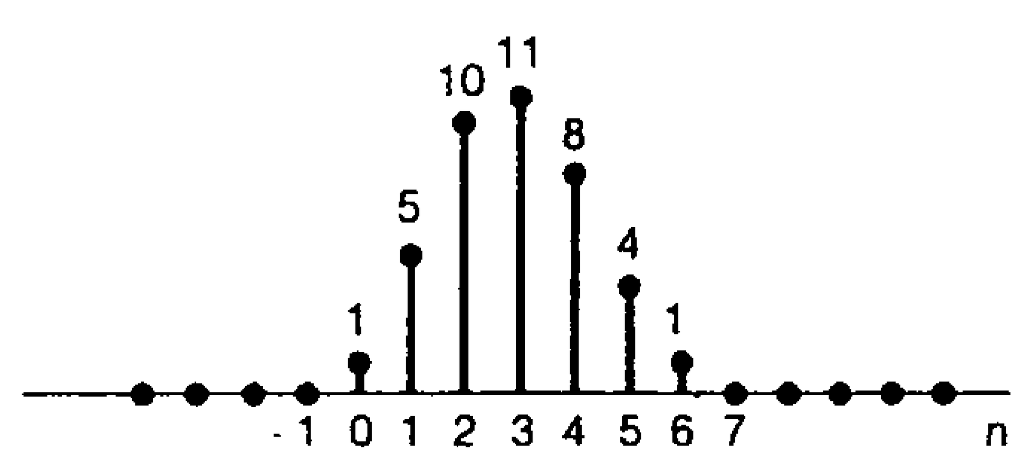


Figure 2(b)

參考用

三、(15%)

(a) (5%) Evaluate the following discrete-time convolution

$$y[n] = (-u[n] + 2u[n-3] - u[n-6]) * (u[n+1] - u[n-10])$$

(b) (5%) Find the Fourier transform of $e^{-\alpha t}u(t)$ ;

(5%) Use partial-fraction expansions to determine the time-domain signals corresponding to the following Fourier transforms

$$x(jw) = \frac{2(jw)^2 + 5jw - 9}{(-w^2 + 4jw + 3)(jw + 4)}$$

四、(15%) Find the Fourier transform representation of the following periodic signals:

(a) (5%) $x(t) = \sin(w_0 t)$

(b) (5%) The periodic square wave depicted in Figure 3

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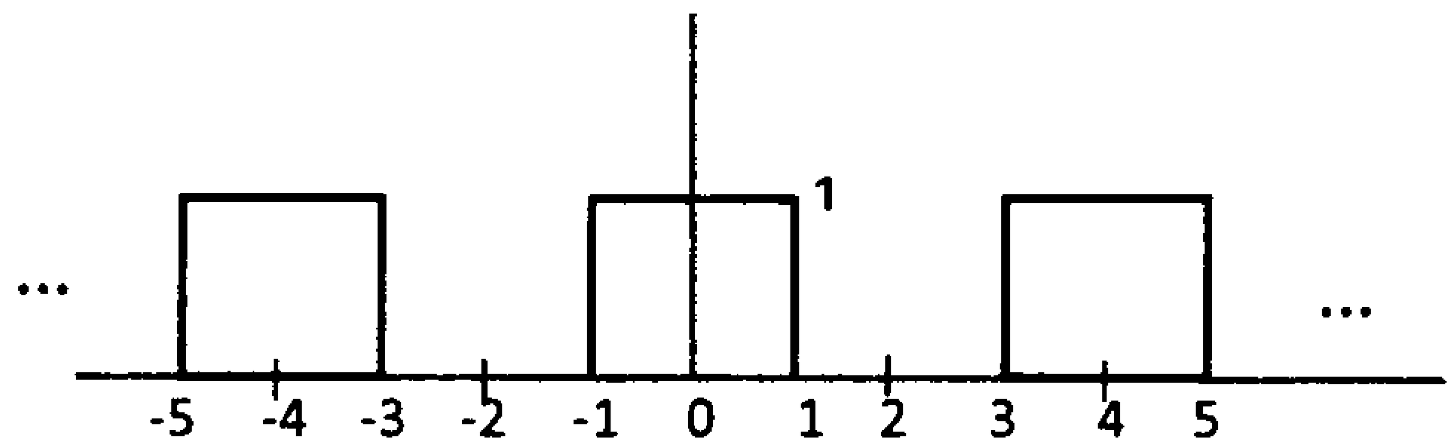


Figure 3

(c) (5%) $x(t) = |\sin(\pi t)|$

五、(15%) An LTI system has impulse response $h(t) = 2\cos(4\pi t)\frac{\sin(\pi t)}{\pi t}$. Use the Fourier transform to determine the output if the input is

(a) (5%) $x(t) = 1 + \cos(\pi t) + \sin(4\pi t)$

(b) (5%) $x(t) = \sum_{m=-\infty}^{m=\infty} \delta(t - m)$

(c) (5%) $x(t)$ as depicted in the Figure 4

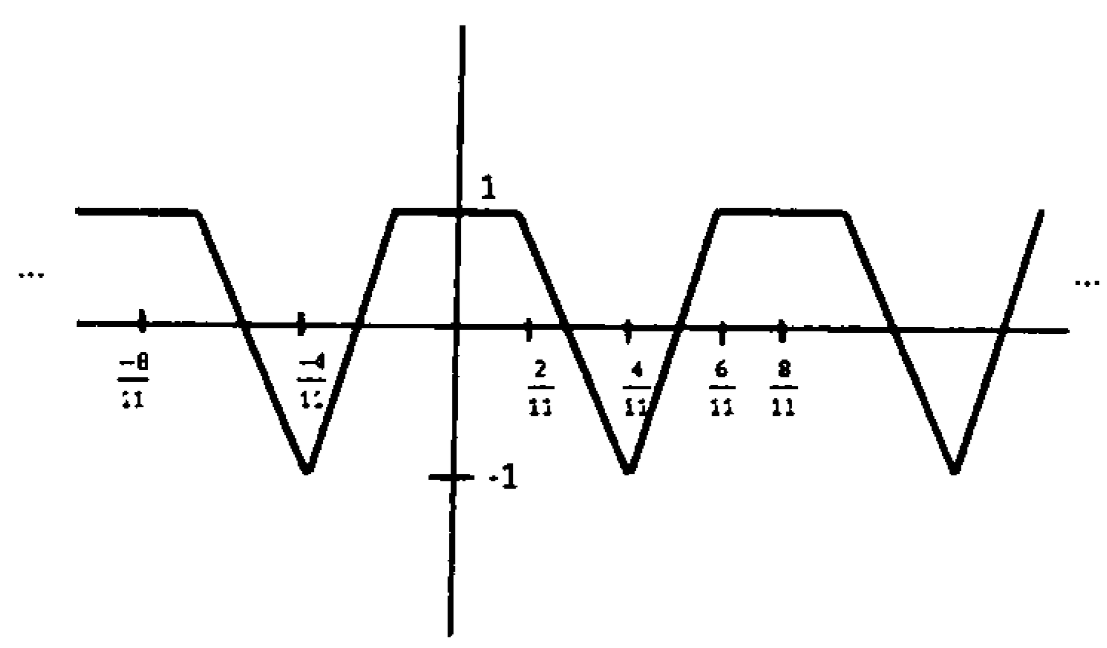


Figure 4

參考用

六、(10%)

(a) (5%) Shown in Figure 5 is a system that processes continuous-time signals using a digital filter $h[n]$ that is linear and causal with difference equation $y[n] = \frac{1}{2}y[n-1] + x[n]$. For input signals that are band limited such that $X_c(j\omega) = 0$ for $|\omega| > \pi/T$, the system in the figure is equivalent to a continuous-time LTI system. Let the frequency response of the equivalent continuous-time LTI system with input $x_c(t)$ and output $y_c(t)$ be denoted as $H_c(j\omega)$, then $H_c(j\omega) =$ ________________. (You need to write down your answers only. No partial scores for your computation procedures.)

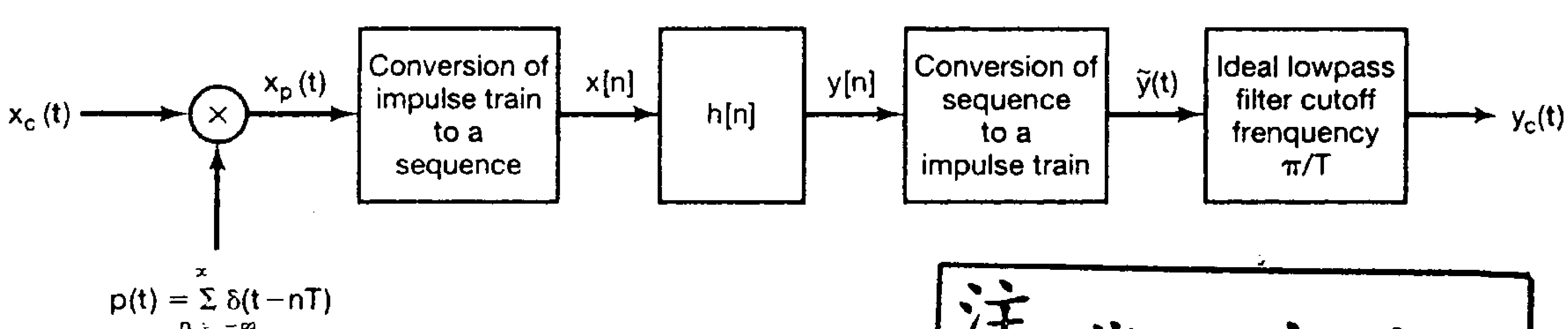


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Figure 5

(b) (5%) In the discrete-time system shown in Figure 6, $S_A$ corresponds to a zero insertion system that inserts one zero after every input sample, while $S_B$ corresponds to a decimation system that extracts every second sample of its input. The overall system is equivalent to a filter with frequency response $H(e^{j\omega}) = \begin{cases} A, & |\omega| < B\cdot\pi \\ 0, & B\cdot\pi < |\omega| \le \pi \end{cases}$. Then $A + B =$__________. (You need to write down your answers only. No partial scores for your computation procedures.)

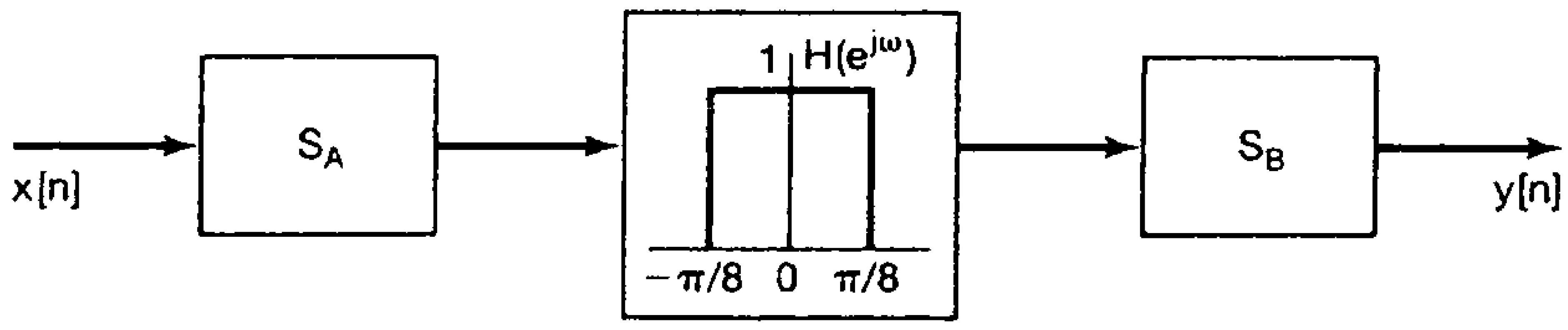


Figure 6

七、(15%) Consider the continuous-time LTI system with input $x(t)$, output $y(t)$ and impulse response $h(t)$, for which we are given the following information:

$x(t) = 0,\ t > 0$ and $X(s) = (s + 2)/(s - 2)$, and $y(t) = -\frac{2}{3}e^{2t}u(-t) + \frac{1}{3}e^{-t}u(t)$.

(a) (10%) Determine the transfer function, $H(s)$, of the system (3%), its region of convergence (2%), and the impulse response $h(t)$ of the system (5%).

(b) (5%) What is the output $y(t)$ if the input to the LTI system is $x(t) = e^{-3t}$, $-\infty < t < \infty$?

八、(15%) When the input to a causal LTI system is $x[n] = -\frac{1}{3}\left(\frac{1}{3}\right)^n u[n] - \frac{4}{3}2^n u[-n-1]$, the $z$-transform of the output is $Y(z) = \dfrac{1 + z^{-1}}{(1 - z^{-1})(1 + 0.5z^{-1})(1 - 2z^{-1})}$.

(a) (5%) Find the $z$-transform of $x[n]$.

(b) (4%) What is the region of convergence of $Y(z)$?

(c) (4%) Find the impulse response of the system.

(d) (2%) Is the system stable?