國 立 臺 北 科 技 大 學

一百學年第二學期電機系博士班資格考試

高等數位訊號處理 試題

注意事項：

1. 本試題共【7】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。
4. 考試時間:二小時。
5. **可以使用計算器(計算機)**

1. By direct computation of the convolution sum, determine the unit step response (i.e. input $x[n]=u[n]$) of an LTI system whose impulse response is

$$h[n]=a^{-n}u[-n], \quad 0<a<1.$$

(15 %)

2. A causal LTI system has the system function

$$H(z)=\frac{1+2z^{-1}+z^{-2}}{(1+\frac{1}{2}z^{-1})(1-z^{-1})},$$

Find the impulse response of the system, $h[n]$.
(15 %)

3. Consider the cascade of two LTI discrete-time systems as shown in Figure 1. The first system is described by the frequency response $H_1(e^{j\omega})=e^{-j\omega}\times\begin{cases}0, & |\omega|\le 0.25\pi,\\ 1, & 0.25\pi<|\omega|\le\pi,\end{cases}$ and the second system is described by the impulse response $h_2[n]=2\frac{\sin(0.5\pi n)}{\pi n}$.

(a) Define the frequency response, $H(e^{j\omega})$, of the overall system over the range

$-\pi \le \omega \le \pi$.

(b) Determine the impulse response $h[n]$ of the overall cascade system.

(15 %)

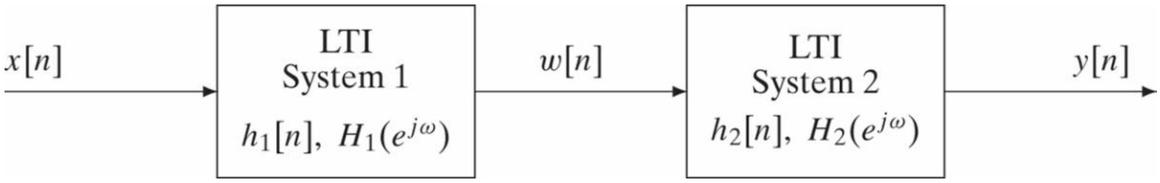

Figure 1

4. In the system of Figure 2, $X_C(j\Omega)$ and $H(e^{j\omega})$ are as shown. Sketch the Fourier transform of $y_C(t)$ for $1/T_1 = 10^4$ and $1/T_2 = 2\times10^4$.

(15 %)

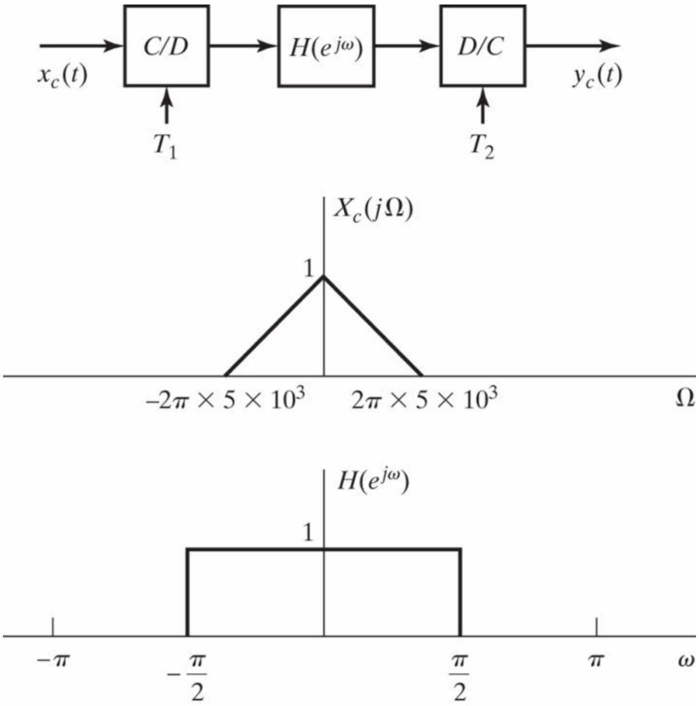

Figure 2

5. The butterfly in Figure 3 was taken from a decimation-in-time FFT with $N = 16$. Assume that the four stages of the signal flow graph from input to output are indexed by $m = 1, \cdots, 4$. What are the possible values of r for the second and third stages?
(15 %)

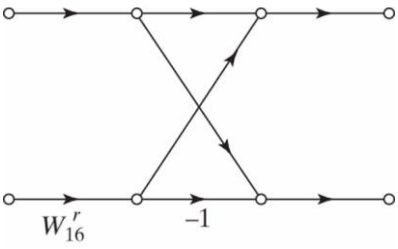

Figure 3

6. Figure 4 shows two finite-length sequences $x_1[n]$ and $x_2[n]$. Let $x_3[n]$ be the six-point circular convolution of $x_1[n]$ and $x_2[n]$. Determine $x_3[n]$.
(15 %)

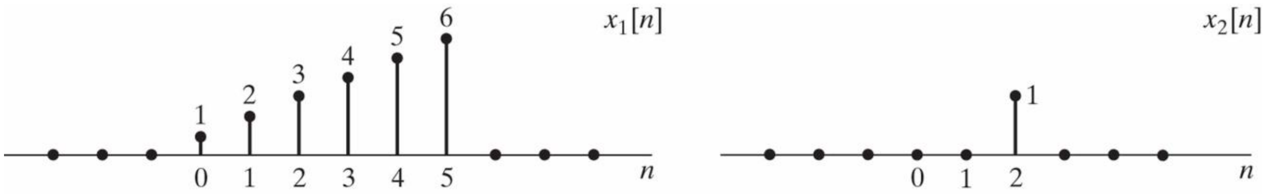

Figure 4

7. A continuous-time signal $x_C(t)$ is bandlimited to 5 kHz. The signal is sampled with a sampling rate of 10,000 samples per second (10 kHz) to produce a sequence $x[n]=x_C(nT)$. Let $X[k]$ be the 1000-point DFT of $x[n]$.
(a) To what continuous-time frequency does the index $k=150$ in $X[k]$ correspond?
(b) To what continuous-time frequency does the index $k=800$ in $X[k]$ correspond?
(10 %)