# 國 立 臺 北 科 技 大 學

## 九十八學年第一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；可使用計算器作答。
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。

1. The input–output pair shown in Figure 1 is given for a stable LTI system. (15 %)

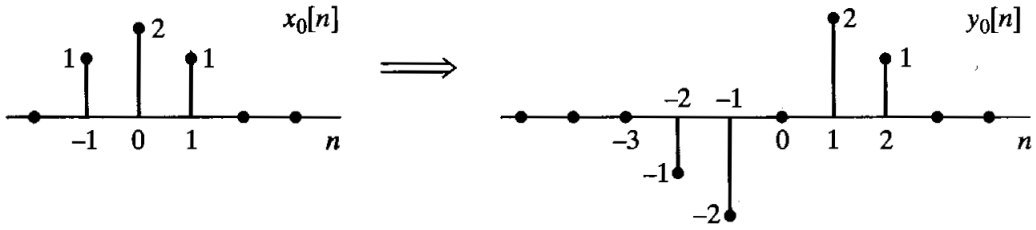


**Figure 1**

(a) Determine the response to the input $x_1[n]$ in Figure 2.

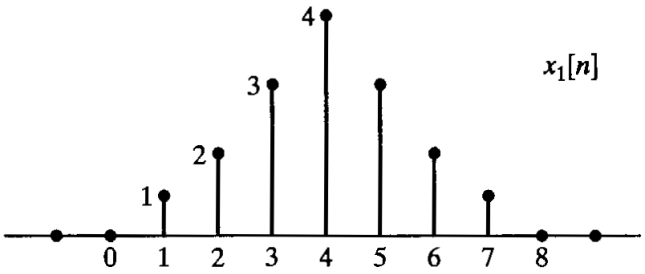


**Figure 2**

(b) Determine the impulse response of the system.

2. The system function of a causal LTI system is

$$H(z) = \frac{1 - z^{-1}}{1 + \frac{3}{4}z^{-1}}$$

The input to this system is $x[n] = \left(\frac{1}{3}\right)^n u[n] + u[-n-1]$. (15 %)

(a) Find the impulse response of the system $h[n]$.

(b) Find the output $y[n]$.

3. A continuous-time signal $x_c(t)$, with Fourier transform $X_c(j\omega)$ shown in Figure 3, is sampled with sampling period $T = 2\pi/\Omega_0$ to form the sequence $x[n] = x_c(nT)$. (15 %)

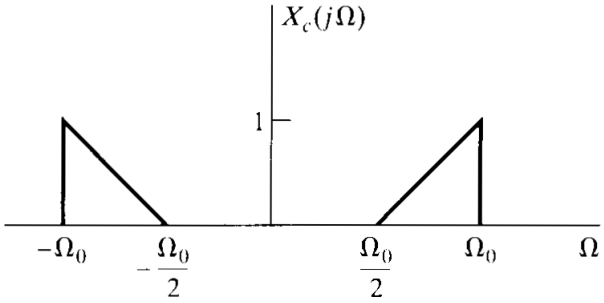


**Figure 3**

(a) Sketch the Fourier transform of $x[n]$, $X(e^{j\omega})$ for $|\omega| < \pi$ .

(b) In terms of $\Omega_0$, what range of values of $T$ can $x_c(t)$ be recovered from $x[n]$? Assume that ideal filters are available.

4. Consider the system in Figure 4. Find the system function relating the z-transforms of the input and output. (15 %)

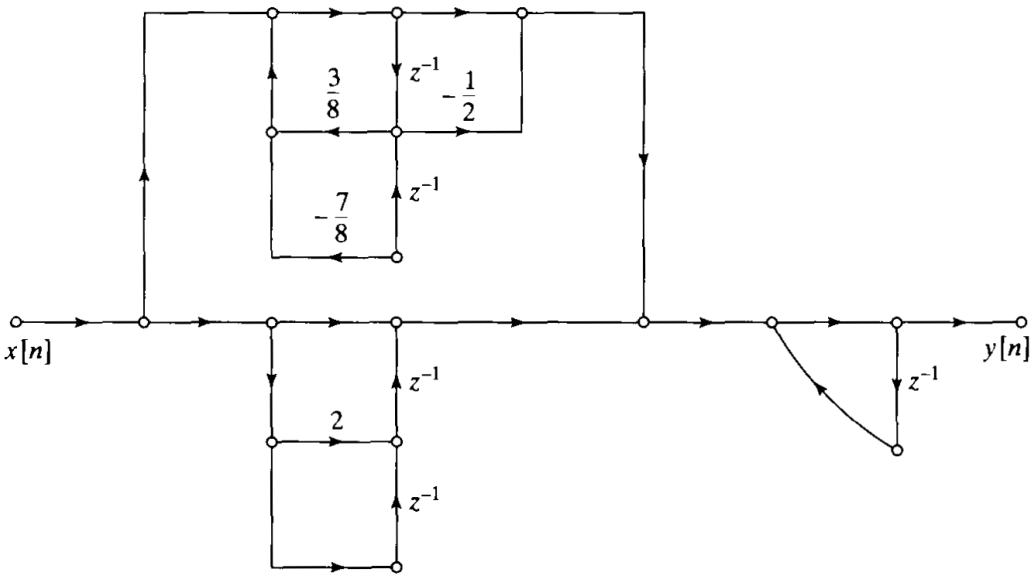


**Figure 4**

5. Consider a causal continuous-time system with impulse response $h_c(t)$ and system function

$$H_c(s) = \frac{s+a}{(s+a)^2 + b^2}$$

Use impulse invariance to determine $H(z)$ for a discrete-time system such that $h[n] = h_c(nT)$. (15 %)

6. Figure 5 shows two periodic sequences, $\tilde{x}_1[n]$ and $\tilde{x}_2[n]$, with period $N$ = 7. (15 %) Find a sequence $\tilde{y}[n]$ whose DFS is equal to the product of the DFS of $\tilde{x}_1[n]$ and the DFS of $\tilde{x}_2[n]$, i.e.,

$$\tilde{Y}[k] = \tilde{X}_1[k]\tilde{X}_2[k]$$

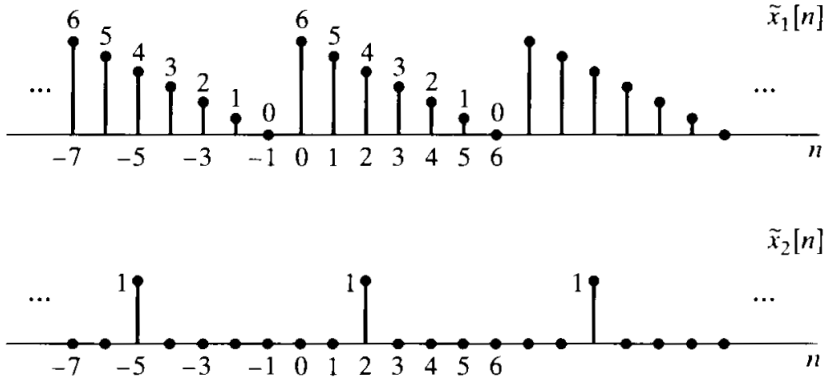


**Figure 5**

7. Figure 6 shows the flow graph for an 8-point decimation-in-time FFT algorithm. Let $x[n]$ be the sequence whose DFT is $X[k]$. Specify how the elements of the sequence $x[n]$ should be placed in the array $A[r], r = 0, 1, \cdots, 7$. Also, specify how the elements of the DFT sequence $X[k]$ should be extracted from the array $D[r], r = 0, 1, \cdots, 7$. (10 %)

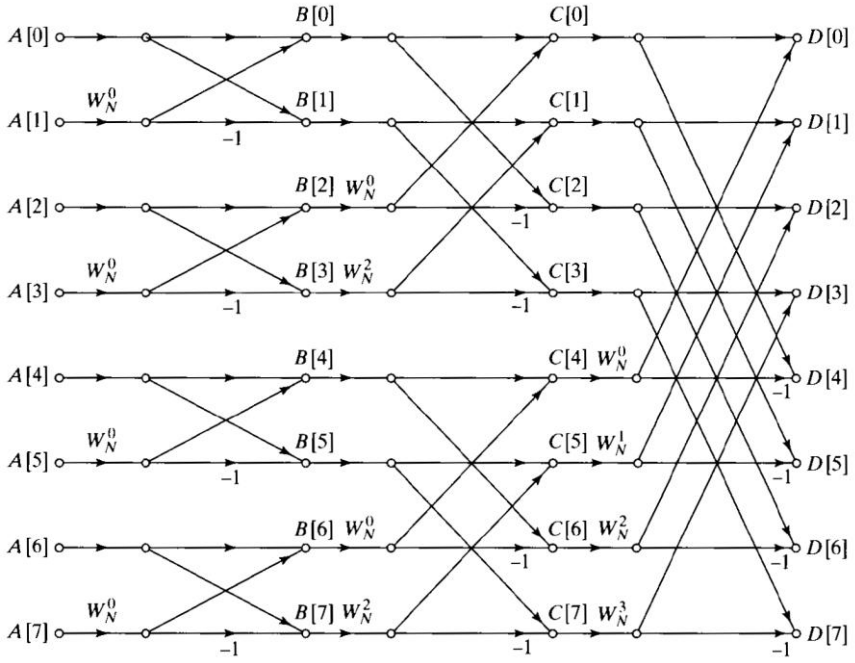


**Figure 6**