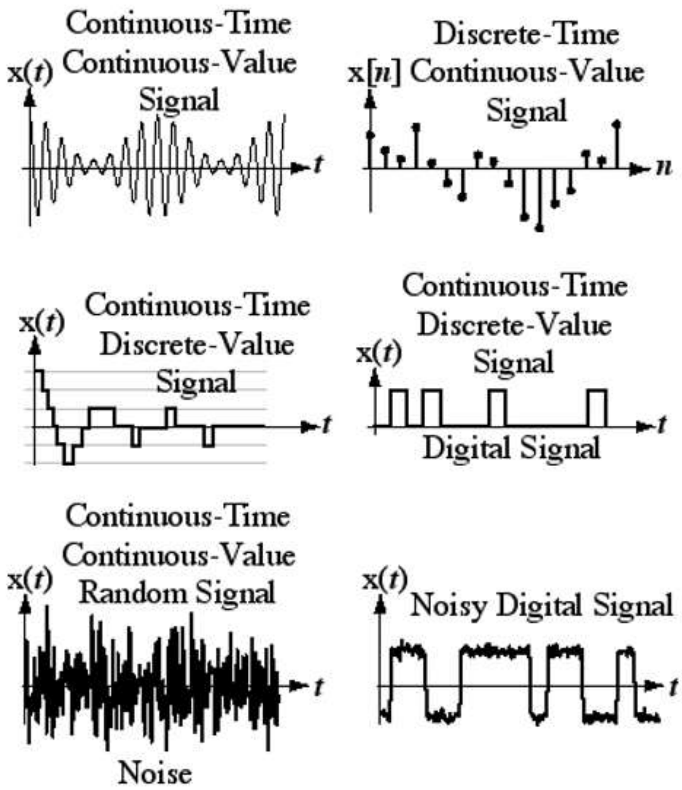
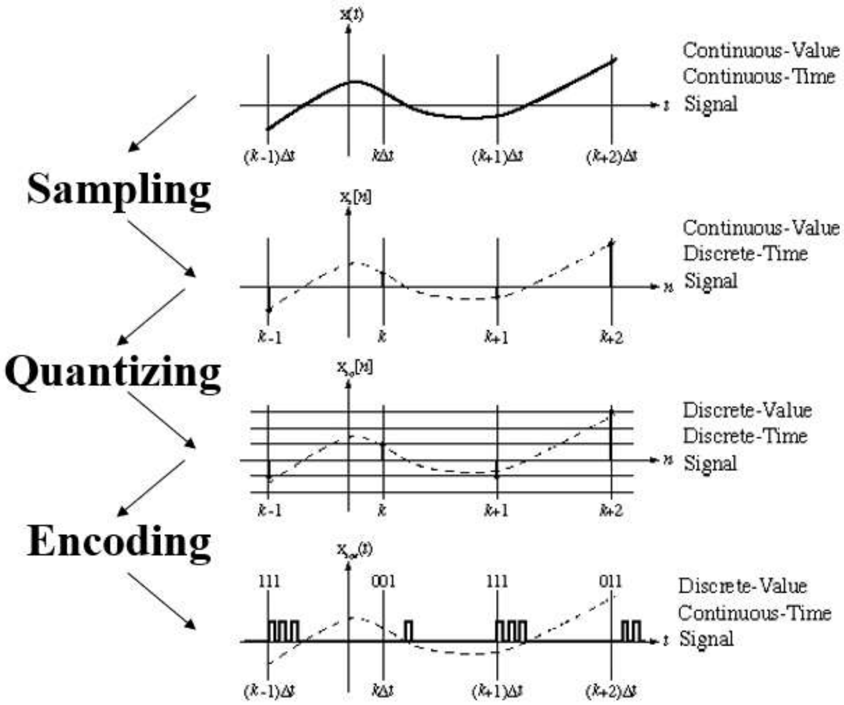
1. Sinyaller verilip sinyal tipleri belirleme sorulacak



2. Örnekleme, kuantalama, kodlama Sf.5'deki sinyal grafiklerini çalışın, çizin.



3. Sf.12 y[n]=1.97y[n-1]-[n-2] blok diyagramını çizimine ve ayrık sistem tanımına çalışın benzeri sorulacak

Discrete-Time Systems

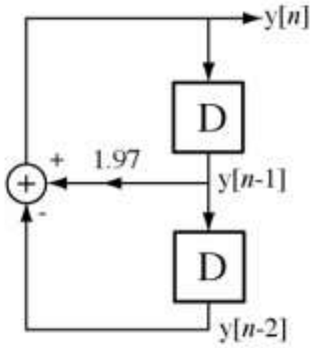
$$y[n] = 1.97\, y[n-1] - y[n-2]$$

We could solve this equation by iteration using a computer.

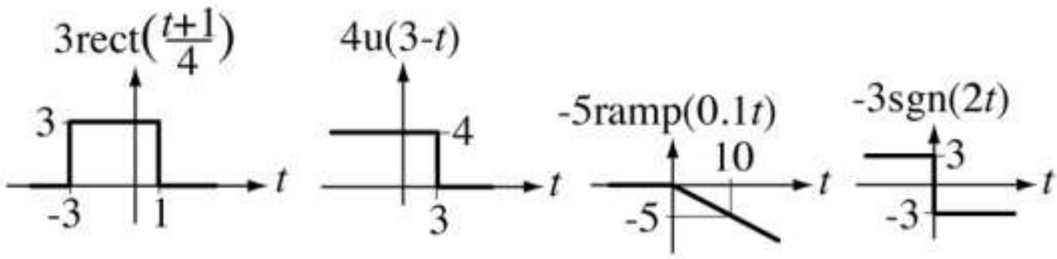
```
yn = 1 ; yn1 = 0 ;          ← Initial Conditions
while 1,
   yn2 = yn1 ; yn1 = yn ; yn = 1.97*yn1 - yn2 ;
end
```

We could also describe the system with a **block diagram**.

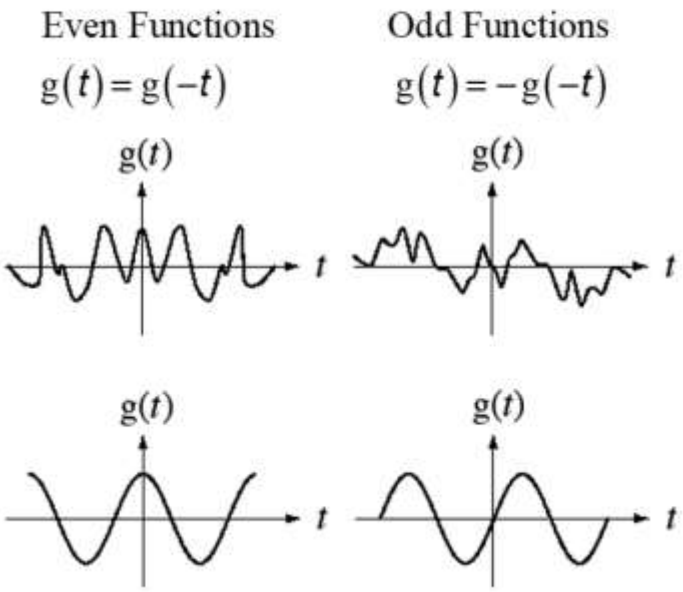
("D" means delay one unit in discrete time.)

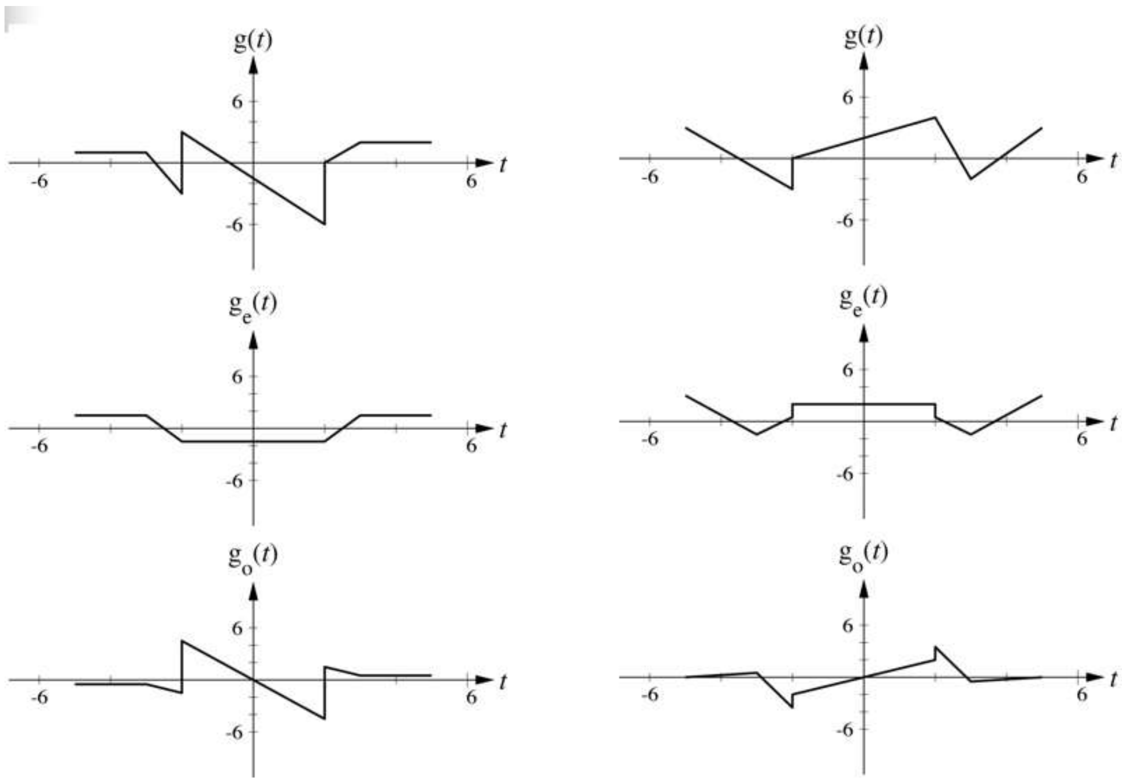


4. Sf. 5 Kaydırma ve Skalalama Fonksiyonlarını dikdörtgen dalga üstünden çalışın benzeri sorulacak. 3 rect(t+1/4)...



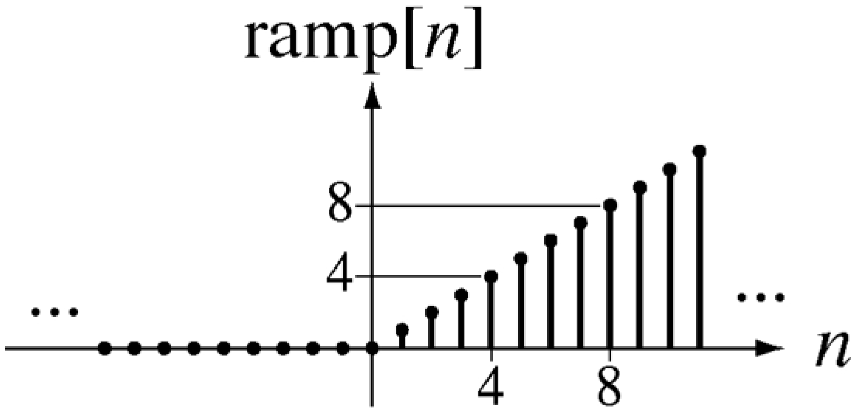
5. Sf.7 Verilen fonksiyonun hangilerinin çift ya da tek olduğunu yazın. Örneklere çalışın benzeri sorulacak.





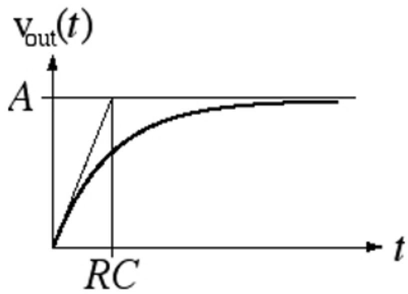
6. Unit Rampa Funksiyonunu (Unit Ramp Function) matematiksel ifadesini yazıp grafiksel olarak gösteriniz. Sf. 12-15

$$\text{ramp}[n] = \begin{cases} n , & n \geq 0 \\ 0 , & n < 0 \end{cases} = n\,\text{u}[n] = \sum_{m=-\infty}^{n} \text{u}[m-1]$$



7. Bir RC Filtresinin Sıfır-Durum Cevabını (t=0) Zero-State Response verilen Vi ve Vo giriş çıkış sinyallaerine göre çizip açıklayınız. Sf.10

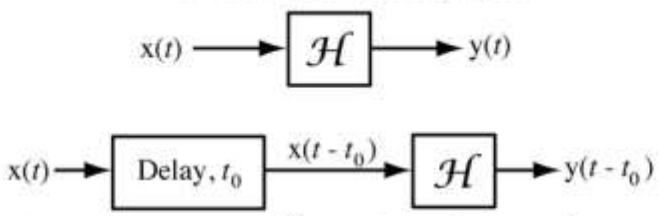
If an RC lowpass filter with an initially uncharged capacitor is excited by a step of voltage $\text{v}_{in}(t) = A\text{u}(t)$ its response is $\text{v}_{out}(t) = A\left(1 - e^{-t/RC}\right)\text{u}(t)$. This response is called the **zero-state** response of this system because there was initially no energy stored in the system. (It was in its zero-energy state.) If the excitation is doubled, the zero-state response also doubles.



8. Time-Invariance (Zamanda Değişmezlik) nedir? Verilensistemin Time-Invariant olup olmadığını belirleyin sf. 16’daki örnek benzeri sorulacak. Sf. 16

- If an excitation causes a zero-state response and delaying the excitation simply delays the zero-state response by the same amount of time, regardless of the amount of delay, the system is **time invariant**.

Time Invariant System



If $g(t) \xrightarrow{\mathcal{H}} y_1(t)$ and $g(t-t_0) \xrightarrow{\mathcal{H}} y_1(t-t_0)$ □ $\mathcal{H}$ is Time Invariant

This test must succeed for any g and any t_0.

Let $y(t) = \exp(x(t))$. Is this system time invariant?

Let $x_1(t) = g(t)$. Then $y_1(t) = \exp(g(t))$.

Let $x_2(t) = g(t-t_0)$. Then $y_2(t) = \exp(g(t-t_0))$

$y_1(t-t_0) = \exp(g(t-t_0))$ □ $y_2(t) = y_1(t-t_0)$, Time Invariant

Let $y(t) = x(t/2)$. Is this system time invariant?

Let $x_1(t) = g(t)$. Then $y_1(t) = g(t/2)$.

Let $x_2(t) = g(t-t_0)$. Then $y_2(t) = g(t/2-t_0)$

$y_1(t-t_0) = g((t-t_0)/2)$ □ $y_2(t) \neq y_1(t-t_0)$, Time **Variant**

9. Konvolüsyon İntegral (Convolution Integral) ve Convolution Toplam (Convolution Sum) formüllerini yazıp basit sistemlerini çizip açıklayınız. Sf. 57-62

C. Convolution Integral:

Equation (2.5) defines the *convolution* of two continuous-time signals $x(t)$ and $h(t)$ denoted by

$$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)\,d\tau \tag{2.6}$$

Equation (2.6) is commonly called the *convolution integral*. Thus, we have the fundamental result that *the output of any continuous-time LTI system is the convolution of the input* $x(t)$ *with the impulse response* $h(t)$ *of the system*. Figure 2-1 illustrates the definition of the impulse response $h(t)$ and the relationship of Eq. (2.6).

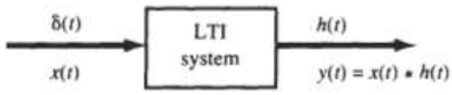


Fig. 2-1 Continuous-time LTI system.

D. Properties of the Convolution Integral:

The convolution integral has the following properties.

1. Commutative:

$$x(t) * h(t) = h(t) * x(t) \tag{2.7}$$

2. Associative:

$$\{x(t) * h_1(t)\} * h_2(t) = x(t) * \{h_1(t) * h_2(t)\} \tag{2.8}$$

3. Distributive:

$$x(t) * \{h_1(t)\} + h_2(t)\} = x(t) * h_1(t) + x(t) * h_2(t) \tag{2.9}$$

C. Convolution Sum:

Equation (2.34) defines the *convolution* of two sequences $x[n]$ and $h[n]$ denoted by

$$y[n] = x[n] * h[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k] \tag{2.35}$$

Equation (2.35) is commonly called the *convolution sum*. Thus, again, we have the fundamental result that *the output of any discrete-time LTI system is the convolution of the input* $x[n]$ *with the impulse response* $h[n]$ *of the system*.

Figure 2-3 illustrates the definition of the impulse response $h[n]$ and the relationship of Eq. (2.35).

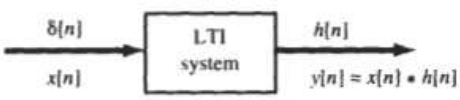


Fig. 2-3 Discrete-time LTI system.

D. Properties of the Convolution Sum:

The following properties of the convolution sum are analogous to the convolution integral properties shown in Sec. 2.3.

1. Commutative:

$$x[n] * h[n] = h[n] * x[n] \tag{2.36}$$

2. Associative:

$$\{x[n] * h_1[n]\} * h_2[n] = x[n] * \{h_1[n] * h_2[n]\} \tag{2.37}$$

3. Distributive:

$$x[n] * \{h_1[n]\} + h_2[n]\} = x[n] * h_1[n] + x[n] * h_2[n] \tag{2.38}$$

10. Sf. 233'da Çözümlü problemler 5.4 (c)örneğine çalışın benzeri sorulacak.

5.4. Determine the complex exponential Fourier series representation for each of the following signals:

(a) $x(t) = \cos \omega_0 t$

(b) $x(t) = \sin \omega_0 t$

(c) $x(t) = \cos\left(2t + \dfrac{\pi}{4}\right)$

(d) $x(t) = \cos 4t + \sin 6t$

(e) $x(t) = \sin^2 t$

(a) Rather than using Eq. (5.5) to evaluate the complex Fourier coefficients c_k using Euler's formula, we get

$$\cos \omega_0 t = \frac{1}{2}\left(e^{j\omega_0 t} + e^{-j\omega_0 t}\right) = \frac{1}{2}e^{-j\omega_0 t} + \frac{1}{2}e^{j\omega_0 t} = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t}$$

Thus, the complex Fourier coefficients for $\cos \omega_0 t$ are

$$c_1 = \tfrac{1}{2} \qquad c_{-1} = \tfrac{1}{2} \qquad c_k = 0, \ |k| \neq 1$$

(b) In a similar fashion we have

$$\sin \omega_0 t = \frac{1}{2j}\left(e^{j\omega_0 t} - e^{-j\omega_0 t}\right) = -\frac{1}{2j}e^{-j\omega_0 t} + \frac{1}{2j}e^{j\omega_0 t} = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t}$$

Thus, the complex Fourier coefficients for $\sin \omega_0 t$ are

$$c_1 = \frac{1}{2j} \qquad c_{-1} = -\frac{1}{2j} \qquad c_k = 0, \ |k| \neq 1$$

(c) The fundamental angular frequency ω_0 of $x(t)$ is 2. Thus,

$$x(t) = \cos\left(2t + \frac{\pi}{4}\right) = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t} = \sum_{k=-\infty}^{\infty} c_k e^{j2kt}$$

Now

$$x(t) = \cos\left(2t + \frac{\pi}{4}\right) = \frac{1}{2}\left(e^{j(2t+\pi/4)} + e^{-j(2t+\pi/4)}\right)$$

$$= \frac{1}{2}e^{-j\pi/4}e^{-j2t} + \frac{1}{2}e^{j\pi/4}e^{j2t} = \sum_{k=-\infty}^{\infty} c_k e^{j2kt}$$

Thus, the complex Fourier coefficients for $\cos(2t + \pi/4)$ are

$$c_1 = \frac{1}{2}e^{j\pi/4} = \frac{1}{2}\frac{1+j}{\sqrt{2}} = \frac{\sqrt{2}}{4}(1+j)$$

$$c_{-1} = \frac{1}{2}e^{-j\pi/4} = \frac{1}{2}\frac{1-j}{\sqrt{2}} = \frac{\sqrt{2}}{4}(1-j)$$

$$c_k = 0 \qquad |k| \neq 1$$

(d) By the result from Prob. 1.14 the fundamental period T_0 of $x(t)$ is π and $\omega_0 = 2\pi/T_0 = 2$. Thus,

$$x(t) = \cos 4t + \sin 6t = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t} = \sum_{k=-\infty}^{\infty} c_k e^{j2kt}$$

Again using Euler's formula, we have

$$x(t) = \cos 4t + \sin 6t = \frac{1}{2}(e^{j4t} + e^{-j4t}) + \frac{1}{2j}(e^{j6t} - e^{-j6t})$$

$$= -\frac{1}{2j}e^{-j6t} + \frac{1}{2}e^{-j4t} + \frac{1}{2}e^{j4t} + \frac{1}{2j}e^{j6t} = \sum_{k=-\infty}^{\infty} c_k e^{j2kt}$$

Thus, the complex Fourier coefficients for $\cos 4t + \sin 6t$ are

$$c_{-3} = -\frac{1}{2j} \qquad c_{-2} = \frac{1}{2} \qquad c_2 = \frac{1}{2} \qquad c_3 = \frac{1}{2j}$$

and all other $c_k = 0$.

(e) From Prob. 1.16(e) the fundamental period T_0 of $x(t)$ is π and $\omega_0 = 2\pi/T_0 = 2$. Thus,

$$x(t) = \sin^2 t = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t} = \sum_{k=-\infty}^{\infty} c_k e^{j2kt}$$

Again using Euler's formula, we get

$$x(t) = \sin^2 t = \left(\frac{e^{jt} - e^{-jt}}{2j}\right)^2 = -\frac{1}{4}(e^{j2t} - 2 + e^{-j2t})$$

$$= -\frac{1}{4}e^{-j2t} + \frac{1}{2} - \frac{1}{4}e^{j2t} = \sum_{k=-\infty}^{\infty} c_k e^{j2kt}$$

Thus, the complex Fourier coefficients for $\sin^2 t$ are

$$c_{-1} = -\tfrac{1}{4} \qquad c_0 = \tfrac{1}{2} \qquad c_1 = -\tfrac{1}{4}$$

and all other $c_k = 0$.

11. Schaums Signal and Systems Chapter 4 Solved Problemes 4.1 ve 4.3 örneklerine çalışın benzeri sorulacak.

4.1. Find the z-transform of

(a) $x[n] = -a^n u[-n-1]$

(b) $x[n] = a^{-n} u[-n-1]$

(a) From Eq. (4.3)

$$X(z) = -\sum_{n=-\infty}^{\infty} a^n u[-n-1] z^{-n} = -\sum_{n=-\infty}^{-1} a^n z^{-n}$$

$$= -\sum_{n=1}^{\infty} (a^{-1}z)^n = 1 - \sum_{n=0}^{\infty} (a^{-1}z)^n$$

By Eq. (1.91)

$$\sum_{n=0}^{\infty} (a^{-1}z)^n = \frac{1}{1-a^{-1}z} \qquad \text{if } |a^{-1}z| < 1 \text{ or } |z| < |a|$$

Thus,

$$X(z) = 1 - \frac{1}{1-a^{-1}z} = \frac{-a^{-1}z}{1-a^{-1}z} = \frac{z}{z-a} = \frac{1}{1-az^{-1}} \qquad |z| < |a| \qquad (4.52)$$

(b) Similarly,

$$X(z) = \sum_{n=-\infty}^{\infty} a^{-n} u[-n-1] z^{-n} = \sum_{n=-\infty}^{-1} (az)^{-n}$$

$$= \sum_{n=1}^{\infty} (az)^n = \sum_{n=0}^{\infty} (az)^n - 1$$

Again by Eq. (1.91)

$$\sum_{n=0}^{\infty} (az)^n = \frac{1}{1-az} \qquad \text{if } |az| < 1 \text{ or } |z| < \frac{1}{|a|}$$

Thus,

$$X(z) = \frac{1}{1-az} - 1 = \frac{az}{1-az} = -\frac{z}{z-1/a} \qquad |z| < \frac{1}{|a|} \qquad (4.53)$$

4.3. A finite sequence $x[n]$ is defined as

$$x[n] = \{5, 3, \underset{\uparrow}{-2}, 0, 4, -3\}$$

Find $X(z)$ and its ROC.

From Eq. (*4.3*) and given $x[n]$ we have

$$\begin{aligned} X(z) &= \sum_{n=-\infty}^{\infty} x[n]z^{-n} = \sum_{n=-2}^{3} x[n]z^{-n} \\ &= x[-2]z^2 + x[-1]z + x[0] + x[1]z^{-1} + x[2]z^{-2} + x[3]z^{-3} \\ &= 5z^2 + 3z - 2 + 4z^{-2} - 3z^{-3} \end{aligned}$$

For z not equal to zero or infinity, each term in $X(z)$ will be finite and consequently $X(z)$ will converge. Note that $X(z)$ includes both positive powers of z and negative powers of z. Thus, from the result of Prob. 4.2 we conclude that the ROC of $X(z)$ is $0 < |z| < \infty$.