

an important  
illustrate some  
poles, zeros,  
response.  
eigenfunction  
the complex  
(2). Also, from  
the frequency  
function of the  
, and impulse  
(10.96)  
representation of  
10.5.7,

ng properties  
pairs 9 and 10  
ctions 10.5.4  
0.18. These,  
and 5 follow  
n the proper-  
transform pairs,  
transforms of  
easily evalu-

Example 10.3.  
of the z-  
Chap. 10

TABLE 10.1 PROPERTIES OF THE z-TRANSFORM

Section	Property	Signal	z-Transform	ROC
		$x[n]$ $x_1[n]$ $x_2[n]$	$X(z)$ $X_1(z)$ $X_2(z)$	$R$ $R_1$ $R_2$
10.5.1	Linearity	$ax_1[n] + bx_2[n]$	$aX_1(z) + bX_2(z)$	At least the intersection of $R_1$ and $R_2$
10.5.2	Time shifting	$x[n - n_0]$	$z^{-n_0}X(z)$	$R$ , except for the possible addition or deletion of the origin
10.5.3	Scaling in the z-domain	$e^{j\omega_0 n}x[n]$ $z_0^n x[n]$ $a^r x[n]$	$X(e^{-j\omega_0}z)$ $X\left(\frac{z}{z_0}\right)$ $X(a^{-1}z)$	$R$ $z_0R$ Scaled version of $R$ (i.e., $ a R$ = the set of points $\{ a z\}$ for $z$ in $R$ ) Inverted $R$ (i.e., $R^{-1}$ = the set of points $z^{-1}$ , where $z$ is in $R$ )
10.5.4	Time reversal	$x[-n]$	$X(z^{-1})$	$R^{1/k}$ (i.e., the set of points $z^{1/k}$ , where $z$ is in $R$ )
10.5.5	Time expansion	$x_{(r)}[n] = \begin{cases} x[r], & n = rk \\ 0, & n \neq rk \end{cases}$ for some integer $r$	$X(z^k)$	$R$ At least the intersection of $R_1$ and $R_2$ At least the intersection of $R$ and $ z  > 0$ At least the intersection of $R$ and $ z  > 1$
10.5.6	Conjugation	$x^*[n]$	$X^*(z^*)$	
10.5.7	Convolution	$x_1[n] * x_2[n]$	$X_1(z)X_2(z)$	
10.5.7	First difference	$x[n] - x[n - 1]$	$(1 - z^{-1})X(z)$	
10.5.7	Accumulation	$\sum_{k=-\infty}^n x[k]$	$\frac{1}{1 - z^{-1}}X(z)$	
10.5.8	Differentiation in the z-domain	$nx[n]$	$-z \frac{dX(z)}{dz}$	
10.5.9				

Initial Value Theorem  
If  $x[n] = 0$  for  $n < 0$ , then  
 $x[0] = \lim_{z \rightarrow \infty} X(z)$