Assignment 1

EE3900: Linear Systems and Signal Processing

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Discrete-time Signal Processing

Oppenheim and Schafer

Problem 3.1.(e) Determine the Z-transform, including the region of convergence, for the following sequence

$$x(n) = \delta(n-1) \tag{1}$$

Solution: The Z-transform of a sequence $x(n)$ is defined as

$$X(z) = \mathcal{Z}\{x(n)\} = \sum_{n=-\infty}^{\infty} x(n) z^{-n} \tag{2}$$

The sequence is given by

$$\delta(n-1) = \begin{cases} 1 & n = 1 \\ 0 & n \neq 1 \end{cases} \tag{3}$$

Thus

$$X(z) = \sum_{n=-\infty}^{\infty} \delta(n-1) z^{-n} \tag{4}$$

$$= z^{-1} \tag{5}$$

Since there is only one non-zero term in the sequence, the sum will converge for any non-zero z. Thus, the region of convergence of this Z-transform is

$$|z| > 0 \tag{6}$$

Therefore

$$X(z) = z^{-1} \qquad |z| > 0 \tag{7}$$