

**Example 9-4:** Suppose the system function  $H(z)$  has two roots at  $\{-1, \frac{1}{2}\}$ . Then we can use (??) to form the  $H(z)$  polynomial from the roots as

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

where  $G$  is a scaling value. In order to find  $H(z)$  we need to find  $G$ , which requires that we know an additional fact. In this example, we assume that the value of  $H(z)$  at  $z = 3$  is given as 4. Then  $z^{-1} = \frac{1}{3}$ , and

$$4 = H(z) \Big|_{z=3} = G(1 + (\frac{1}{3}))(1 - \frac{1}{2}(\frac{1}{3})) = (\frac{4}{3})(\frac{5}{6})G$$

Thus  $G = 3.6$ , and we can multiply the two factors to obtain  $H(z) = 3.6 + 1.8z^{-1} - 1.8z^{-2}$ . Finally, we can write the difference equation for this FIR filter as

$$y[n] = 3.6x[n] + 1.8x[n - 1] - 1.8x[n - 2]$$

