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

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

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