Maths Assignment

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Problem Statement

Write the first five terms of the sequence $a_n = \frac{n(n^2+5)}{4}$.

Solution

The relation between $x(n)$ and $u(n)$:

$$x(n) = \left(\frac{(n+1)^3 + 5(n+1)}{4}\right) u(n) \tag{1}$$

Z-transform of $n^k u(k)$ in terms of the k-th derivative of $U(z)$:

$$n^k u(n) \overset{\text{ZT}}{\longleftrightarrow} (-1)^k z^k \frac{d^k}{dz^k} U(z) \tag{2}$$

$$\mathcal{Z}\{nu(n)\} = \frac{z^{-1}}{\left(1-z^{-1}\right)^2} \text{ [ROC: } |z| > 1] \tag{3}$$

$$\mathcal{Z}\{n^2 u(n)\} = \frac{\left(z^{-1}\right)\left(1+\left(z^{-1}\right)\right)}{\left(1-z^{-1}\right)^3} \text{ [ROC: } |z| > 1] \tag{4}$$

$$\mathcal{Z}\{n^3 u(n)\} = \frac{\left(z^{-1}\right)\left(1+4z^{-1}+z^{-2}\right)}{\left(1-z^{-1}\right)^4} \text{ [ROC: } |z| > 1] \tag{5}$$

Referencing the equations (3), (4), and (5).

$$\mathcal{X}\{z\} = \frac{\left(z^{-1}\right)\left(1+4z^{-1}+z^{-2}\right)}{4\left(1-z^{-1}\right)^4} + \frac{3\left(z^{-1}\right)\left(1+z^{-1}\right)}{4\left(1-z^{-1}\right)^3} + \frac{2z^{-1}}{\left(1-z^{-1}\right)^2} + \frac{3}{2\left(1-z^{-1}\right)} \text{ [ROC: } |z| > 1] \tag{6}$$

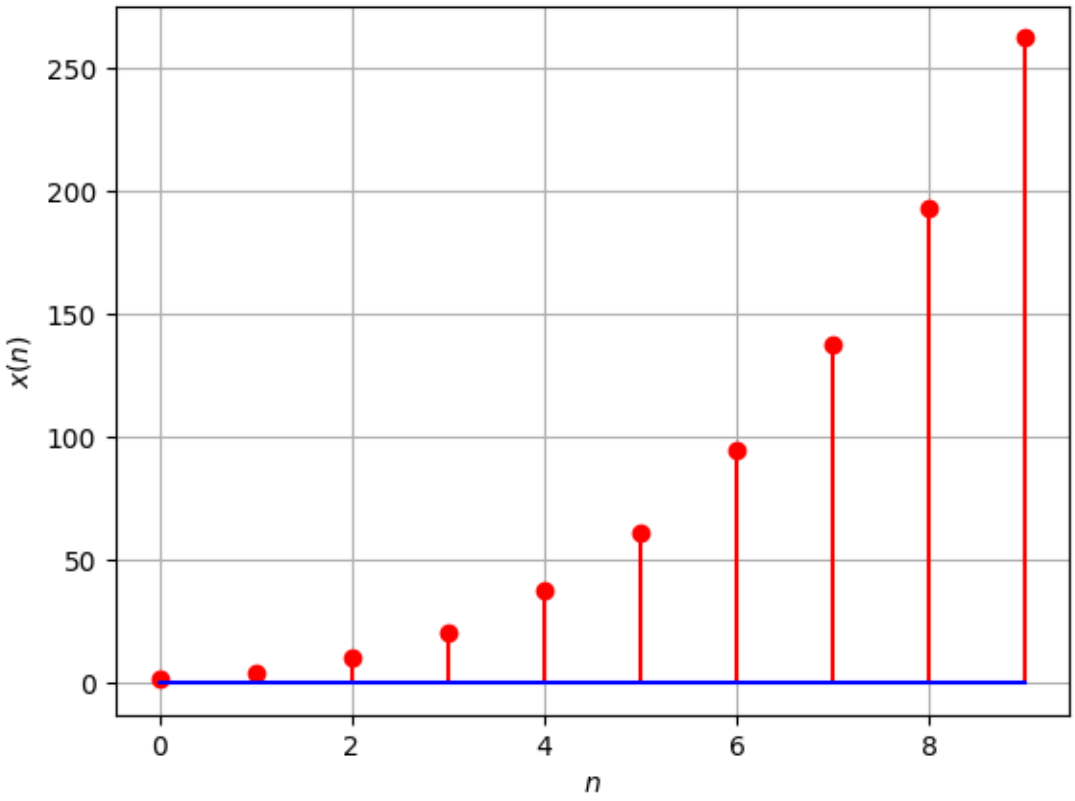

Figure 1: Plot of equation (1)