Elementary Analysis: The Theory of Calculus by Ross Exercise Solutions

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Chapter 1: The Set N of Natural Numbers

1. Prove $1^2 + 2^2 + \cdots + n^2 = \frac{1}{2}n(n+1)(2n+1)$ for all positive integers n

Solution:

Base Case: $1 = \frac{1}{2}(1)(2)(3) = 1$

Inductive Step: Assume that $1^2 + 2^2 + \cdots + n^2 = \frac{1}{2}n(n+1)(2n+1)$ is true for some $n \in \mathbb{N}$. Then,

$$\begin{aligned} 1^2 + 2^2 + \dots + n^2 + (n+1)^2 &= \frac{1}{6}n(n+1)(2n+1) + (n+1)^2 \\ &= \frac{1}{6}n(n+1)(2n+1) + \frac{6(n+1)^2}{6} \\ &= \frac{1}{6}(n+1)[n(2n+1) + 6(n+1)] \\ &= \frac{1}{6}(n+1)[2n^2 + n + 6n + 6] \\ &= \frac{1}{6}(n+1)(n+1+1)(2(n+1) + 1) \end{aligned}$$

Hence, $1^2 + 2^2 + \cdots + n^2 = \frac{1}{8}n(n+1)(2n+1)$ for all $n \in \mathbb{N}$

Prove 3 + 11 + · · · + (8n − 5) = 4n² − n for all positive integers n.

Solution:

Base Case: $3 = 4(1)^2 - 1 = 3$

Inductive Step: Assume that $3 + 11 + \cdots + (8n - 5) = 4n^2 - n$ for some $n \in \mathbb{N}$. Then,

$$3 + 11 + \cdots + (8n - 5) + (8(n + 1) -)5 = 4n^2 - n + (8(n + 1) - 5)$$

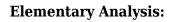
= $4n^2 + 7n + 3$
= $4(n^2 + 2n + 1) - n - 1$
= $4(n + 1)^2 - (n + 1)$

Hence, $3 + 11 + \cdots + (8n - 5) = 4n^2 - n$ for all $n \in \mathbb{N}$

3. Prove $1^3 + 2^3 + \cdots + n^3 = (1 + 2 + \cdots + n)^2$ for all postive integers n

Elementary Analysis

Kenneth A. Ross



Unveiling the Power of Verbal Artistry: An Mental Sojourn through **Elementary Analysis**

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