

# Elementary Analysis: The Theory of Calculus by Ross Exercise Solutions

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## Chapter 1: The Set $\mathbb{N}$ of Natural Numbers

1. Prove  $1^2 + 2^2 + \cdots + n^2 = \frac{1}{6}n(n+1)(2n+1)$  for all positive integers  $n$ .

*Solution:*

Base Case:  $1 = \frac{1}{6}(1)(2)(3) = 1$  ✓

Inductive Step: Assume that  $1^2 + 2^2 + \cdots + n^2 = \frac{1}{6}n(n+1)(2n+1)$  is true for some  $n \in \mathbb{N}$ . Then,

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

Hence,  $1^2 + 2^2 + \cdots + n^2 = \frac{1}{6}n(n+1)(2n+1)$  for all  $n \in \mathbb{N}$  ■

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

$$\begin{aligned}3 + 11 + \cdots + (8n - 5) + (8(n+1) - 5) &= 4n^2 - n + (8(n+1) - 5) \\&= 4n^2 + 7n + 3 \\&= 4(n^2 + 2n + 1) - n - 1 \\&= 4(n+1)^2 - (n+1)\end{aligned}$$

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

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

# Ross Elementary Analysis Solutions

**Michael Seilmaier**



**Ross Elementary Analysis Solutions:**

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