

Elementary Analysis: The Theory of Calculus

Solutions

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

1. The basis for induction is $1^2 = \frac{1}{6} \cdot 1(1+1)(2 \cdot 1 + 1)$. For the induction step, $1^2 + 2^2 + \cdots + n^2 + (n+1)^2 = \frac{1}{6}n(n+1)(2n+1) + (n+1)^2 = \frac{1}{6}n(2n^2 + 3n + 1) + n^2 + 2n + 1 = \frac{1}{3}n^3 + \frac{3}{2}n^2 + \frac{13}{6}n + 1 = \frac{1}{6}(2n^3 + 9n^2 + 13n + 6) = \frac{1}{6}(n+1)(2n^2 + 7n + 6) = \frac{1}{6}(n+1)(n+2)(2n+3) = \frac{1}{6}(n+1)[(n+1)+1][2(n+1)+1]$. The result holds for all natural numbers n by mathematical induction.
2. The basis for induction is $3 = 4 \cdot 1^2 - 1$. For the induction step, $3 + 11 + \cdots + (8n-5) + [8(n+1)-5] = 4n^2 - n + [8(n+1)-5] = 4n^2 + 7n + 3 = 4n^2 + 8n + 4 - (n+1) = 4(n+1)^2 - (n+1)$. The result holds for all natural numbers n by mathematical induction.
3. The basis for induction is $1^3 = 1^2$. For the induction step, $1^3 + 2^3 + \cdots + n^3 + (n+1)^3 = (1 + 2 + \cdots + n)^2 + (n+1)^3 = \left[\frac{1}{2}n(n+1)\right]^2 + (n+1)^3 = \frac{1}{4}n^2(n^2 + 2n + 1) + (n^3 + 3n^2 + 3n + 1) = \frac{1}{4}n^4 + \frac{3}{2}n^3 + \frac{13}{4}n^2 + 3n + 1 = \frac{1}{4}(n^4 + 6n^3 + 13n^2 + 12n + 4) = \frac{1}{4}(n+1)(n^3 + 5n^2 + 8n + 4) = \frac{1}{4}(n+1)^2(n^2 + 4n + 4) = \frac{1}{4}(n+1)^2(n+2)^2 = \left[\frac{1}{2}(n+1)[(n+1)+1]\right]^2 = [1 + 2 + \cdots + (n+1)]^2$. The result holds for all natural numbers n by mathematical induction.
4. (a) For $n = 1, 2, 3, 4$, the sums are (in order) 1, 4, 9, and 16. These are the first four squares, and it would be reasonable to hypothesize that $1 + 3 + \cdots + (2n-1) = n^2$. (b) The basis for induction is $1 = 1^2$. For the induction step, $1 + 3 + \cdots + (2n-1) + [2(n+1)-1] = n^2 + [2(n+1)-1] = n^2 + 2n + 1 = (n+1)^2$. The result holds for all natural numbers n by mathematical induction.
5. The basis for induction is $1 = 2 - \frac{1}{2^0}$. For the induction step, $1 + \frac{1}{2} + \frac{1}{4} + \cdots + \frac{1}{2^n} + \frac{1}{2^{n+1}} = \left(2 - \frac{1}{2^n}\right) + \frac{1}{2^{n+1}} = 2 - \frac{2}{2^{n+1}} + \frac{1}{2^{n+1}} = 2 - \frac{1}{2^{n+1}}$. The result holds for all natural numbers n by mathematical induction.
6. The basis for induction is $11^1 - 4^1 = 7 = 7 \cdot 1$. For the induction step, $11^{n+1} - 4^{n+1} = 11^{n+1} - 11 \cdot 4^n + 11 \cdot 4^n - 4^{n+1} = 11(11^n - 4^n) + 4^n(11 - 4) = 11 \cdot 7m + 7 \cdot 4^n = 7(11m + 4^n)$. The result holds for all natural numbers n by mathematical induction.
7. The basis for induction is $7^1 - 6 \cdot 1 - 1 = 0 = 36 \cdot 0$. For the induction step, $7^{n+1} - 6(n+1) - 1 = 7^{n+1} - 6n - 7 = 7(7^n - 6n - 1) + 36n = 7 \cdot 36m + 36n = 36(7m + n)$. The result holds for all natural numbers n by mathematical induction.
8. (a) The basis for induction is $2^2 = 4 > 3 = 2 + 1$. For the induction step, $(n+1)^2 = n^2 + 2n + 1 > (n+1) + 2n + 1 = 3n + 2 > n + 2 = (n+1) + 1$. The result holds for all natural numbers $n \geq 2$ by mathematical induction. (b) The basis for induction is $4! = 24 > 16 = 4^2$. For the induction step, $(n+1)! = (n+1)n! > (n+1)n^2 > 4n^2 =$

Theory Of Calculus Elementary Analysis Solutions Manual

Jules Bordet



Theory Of Calculus Elementary Analysis Solutions Manual:

Elementary Analysis Kenneth A. Ross,1980-03-03 Designed for students having no previous experience with rigorous proofs this text can be used immediately after standard calculus courses It is highly recommended for anyone planning to study advanced analysis as well as for future secondary school teachers A limited number of concepts involving the real line and functions on the real line are studied while many abstract ideas such as metric spaces and ordered systems are avoided completely A thorough treatment of sequences of numbers is used as a basis for studying standard calculus topics and optional sections invite students to study such topics as metric spaces and Riemann Stieltjes integrals

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