

CHAPTER-1

Sequence and Series of Real Numbers

IF YOU CAN
DREAM IT.
YOU CAN DO IT.

1.1 Introduction to Sequences of Real Numbers

Sequence: It is a function whose domain is the subset of positive integers.

Functional Notation: A sequence is written as $f: S \subseteq \mathbb{N} \rightarrow \mathbb{R}, \exists f(n) = a_n$

Equivalently, the notation $\{a_n\}_{n=n_0}^{\infty}$ or $\{a_n\}$ can be used to denote sequences.

The values $a_1, a_2, \dots, a_n, \dots$ of $\{a_n\}$ are called terms. Generally, for any n , the value a_n is called the n^{th} term of the sequence.

Examples: List the first 4-terms of the following sequences

a) $a_n = \frac{n^2+n}{2n-3}$ b) $a_n = \frac{n!}{2^n}$ c) $a_n = 7 + 2(-1)^n$ d) $a_n = \frac{n+(-2)^n}{(n-1)!}$

Solution: To list a_1, a_2, a_3 & a_4 substitute $n=1, 2, 3$ & 4 in the n^{th} term formula

a) Here, $a_n = \frac{n^2+n}{2n-3} \Rightarrow a_1 = \frac{1+1}{2-3} = -2, a_2 = \frac{4+2}{4-3} = 6, a_3 = \frac{9+3}{6-3} = 4$ & $a_4 = 4$

b) Here, $a_n = \frac{(n+2)!}{2^n} \Rightarrow a_1 = \frac{3!}{2} = 3, a_2 = \frac{4!}{4} = 6, a_3 = \frac{5!}{6} = 20$ & $a_4 = \frac{6!}{8} = 90$

c) Here, $a_n = 7 + 2(-1)^n \Rightarrow a_1 = 7 - 2 = 5, a_2 = 9, a_3 = 5$ & $a_4 = 9$

d) Here, $a_1 = 6, a_2 = 12, a_3 = 3$ & $a_4 = 4$

Recursion Formula: A formula that relates the n^{th} term of a sequence to one or more of the terms that come before the n^{th} term is known as *recursion (recurrence) formula* and we say that the sequence is defined *recursively*.

Examples: List the first 4-terms of a sequence defined recursively by:

a) $a_1 = 4, a_{n+1} = \frac{n a_n}{5-a_n}, n \geq 1$ b) $a_1 = 1, a_2 = 2, a_{n+1} = \frac{a_n^2}{a_{n-1}}, n \geq 2$

c) $a_1 = \sqrt{2}, a_{n-1} = \sqrt{2} a_{n-1}, n \geq 1$ d) $a_1 = 4, a_{n+1} = n^2 a_n - 2n, n \geq 1$

Solution: Use the recursive formula starting from the smallest

a) Here, $a_1 = 4, a_{n+1} = \frac{n a_n}{5-a_n} \Rightarrow a_2 = \frac{a_1}{5-a_1} = \frac{4}{5-4} = 4, a_3 = \frac{2a_2}{5-a_2} = 8, a_4 = -8$

b) Here, $a_{n+1} = \frac{a_n^2}{a_{n-1}} \Rightarrow a_3 = \frac{a_2^2}{a_1} = 4, a_4 = \frac{a_3^2}{a_2} = \frac{16}{2} = 8, a_5 = \frac{a_4^2}{a_3} = \frac{64}{4} = 16$

c) $a_{n+1} = \sqrt{2} a_{n-1} \Rightarrow a_2 = \sqrt{2} a_1 = 2, a_3 = \sqrt{2} a_2 = 2\sqrt{2}$ & $a_4 = \sqrt{2} a_3 = 4$

Applied Mathematics 2

Lauren Gardner



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