Gajendra Purohit

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SERIES OF REAL NUMBERS

Infinite Series : Let $\langle u_n \rangle$ be a given sequence then a symbol of the form $u_1 + u_2 + \ldots u_n + \ldots$ is called infinite series. it is denoted by $\sum_{n=1}^{\infty} u_n$.

Sequence of partial sums of the series : Let $\langle u_n \rangle$ be a sequence and $\sum u_n$ be a series. Then

the sequene $\langle S_n \rangle$ defined by

$S_1 = u_1$,

$S_2 = u_1 + u_2$,

.....

$S_n = u_1 + u_2 + ... + u_n$

The elements of the sequence $\langle S_n \rangle$ are called the partial sums of the series and the sequence $\langle S_n \rangle$ is called sequence of partial sums (SOPS).

Sum of Series : Let $\sum u_n$ be a series and S_n is sequence of partial sum of the series then sum of the series = $\lim_{n\to\infty} S_n$

Geometric Series :

Let us consider the series $1 + a + a^2 + ... + a^n + ...$

Case – 1 If $|a| < 1$.

Then SOPS of this series is $S_n = 1 + a + a^2 + ... + a^{n-1}$

Then $S_n = \frac{1-a^n}{1-a}$ given that $|a| < 1$

So, $\lim_{n\to\infty} S_n = \frac{1}{1-a}$ = Sum of the Series

So, the series is convergent because SOPS of the series is convergent.

Case – 2 If $|a| > 1$

$$S_n = \frac{a^n - 1}{a - 1} \qquad \lim_{n \to \infty} S_n = \infty$$

The series is divergent because SOPS of the series is divergent.

Case – 3 If $a = 1$

$$\sum u_n = \sum_{n=1}^{\infty} (1)^{n-1}$$

$S_1 = 1, S_2 = 1 + 1, S_3 = 1 + 1 + 1, ...$

$$\lim_{n \to \infty} S_n = \infty$$

So, the given series is divergent.

Result : Every constant series is divergent.

Case – 4 If a = -1

$$\sum u_n = \sum_{n=1}^{\infty} (-1)^{n-1}$$

$S_1 = 1, S_2 = 0, S_3 = 1, ...$

SOPS oscillate so the series is oscillating.

Telescopic Series : Let $\langle a_n \rangle$ be a seqence of real numbers, then the series $\sum_{n=1}^{\infty}(a_n - a_{n+1})$ and $\sum_{n=1}^{\infty}(a_{n+1} - a_n)$ are convergent iff the sequence $\langle a_n \rangle$ is convergent.

$$\sum_{n=1}^{\infty}(a_n - a_{n+1}) = a_1 - \lim_{n\to\infty} a_n \quad \text{and} \quad \sum_{n=1}^{\infty}(a_{n+1} - a_n) = \lim_{n\to\infty} a_n - a_1 =$$

= Sum of the Series

Converges of positive term series :

The convergence of a positive terms series $\sum_{n=1}^{\infty} u_n$ depend on the sequence $\langle S_n \rangle$ of the partial sum of the series.

i.e. A series $\sum u_n$ is convergent $\Leftrightarrow$ SOPS is convergent.

A series $\sum u_n$ is divergent $\Leftrightarrow$ SOPS is divergent.

A series $\sum u_n$ oscillate $\Leftrightarrow$ SOPS oscillate.

Q.1. The sum of the series $\sum_{n=1}^{\infty}\left(\frac{3}{4}\right)^{n-1}$ is

(a) 1 (b) 4

(c) 0 (d) does not exist

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Q.2. What is the sum of series

$$\left(\frac{1}{2.3}+\frac{1}{2^2.3}\right)+\left(\frac{1}{2^2.3^2}+\frac{1}{2^3.3^2}\right)+....\left(\frac{1}{2^a.3^a}+\frac{1}{2^{a+1}.3^a}\right)+...$$

CSIR NET JUNE 2019

(a) $\frac{3}{8}$ (b) $\frac{3}{10}$

(c) $\frac{3}{14}$ (d) $\frac{3}{16}$

Results :

(1) $$\sum_{n=1}^{\infty} \frac{1}{n(n+1)(n+2)....(n+m)} = \frac{1}{m} \cdot \frac{1}{\lfloor \underline{m}}$$

(2) $$\sum_{n=1}^{\infty} \frac{1}{n(n+1)(n+2)} = \sum_{n=2}^{\infty} \frac{1}{(n-1)n(n+1)} = \frac{1}{2} \cdot \frac{1}{\lfloor \underline{2}}$$

Q.3. The sum of the series

$$\frac{1}{2(2^2-1)}+\frac{1}{3(3^2-1)}+\frac{1}{4(4^2-1)}+\ldots\ldots?$$

IIT JAM 2020

(a) 1 (b) 0.25

(c) 0.5 (d)2

Q.4. The sum of the series $\sum_{n=1}^{\infty} \frac{1}{(4n-3)(4n+1)}$ is equal to

IIT JAM 2022

(a) 1 (b) 0.5

(c) 0.25 (d) 2

Q.5. The sum of the series $\frac{1}{1!}+\frac{1+2}{2!}+\frac{1+2+3}{3!}+\ldots$ equals :

(a) e

(b) e/2

(c) 3e/2

(d) $1+\frac{e}{2}$

Q.6. $\lim_{n\to\infty} \frac{1}{n^4} \sum_{j=0}^{2n-1} j^3$ equals :

CSIR NET DEC 2016

(a) 4 (b) 16

(c) 1 (d) 8

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▲ 1 • Asked by Manvi

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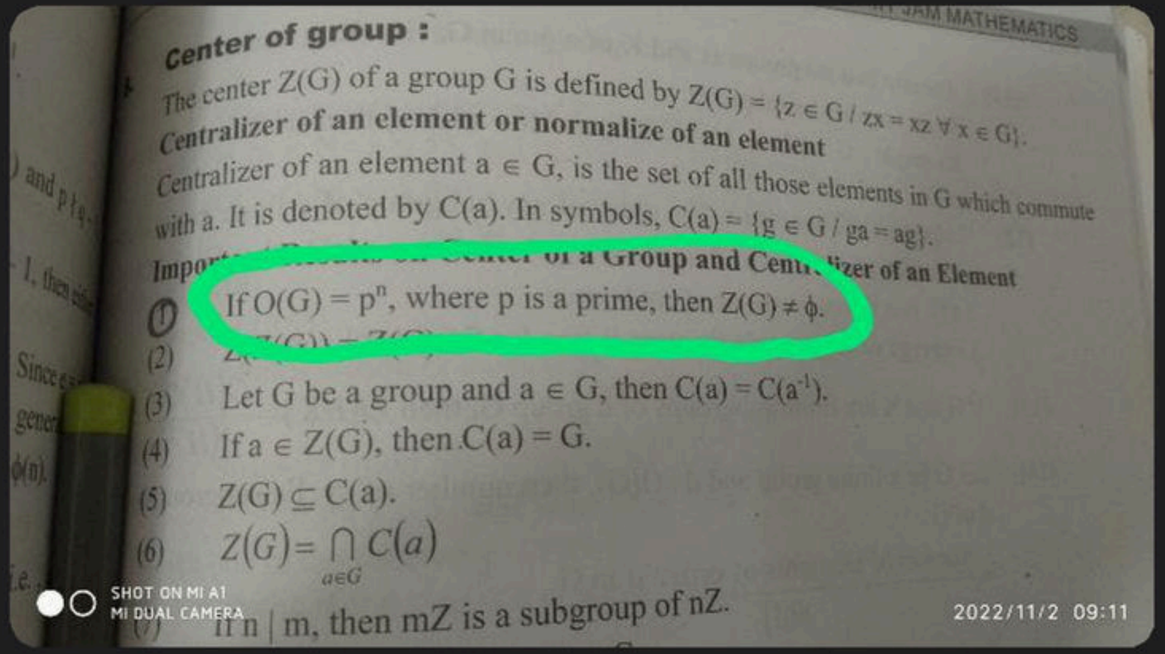

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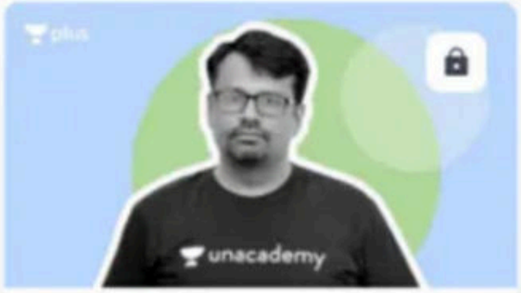

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
- Lives in **Udaipur, Rajasthan, India**
- Unacademy Educator since

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