Gajendra Purohit

Legend in CSIR-UGC NET & IIT-JAM

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SEQUENCE OF REAL NUMBER

Some important theorem on Limit :

(1) If $\lim\limits_{n\to\infty} a_n = l$ then $\lim\limits_{n\to\infty} |a_n| = |l|$ But converse may not true

$\langle a_n \rangle = \langle (-1)^n \rangle$

$\langle |(-1)^n| \rangle \to 1$

(2) **Cauchy's First Theorem :** Let $< a_n >$ be a sequence of real numbers and $\lim_{n\to\infty} a_n = l$ then $\lim_{n\to\infty} \frac{a_1 + a_2 + \ldots\ldots + a_n}{n} = l$

$$\lim_{n\to\infty} \frac{1 + \frac{1}{2} + \cdots \frac{1}{n}}{n} = 0$$

$$\lim_{n\to\infty} \frac{1}{n} = 0$$

Q1. Find the Limit of $\dfrac{1+\sqrt{2}+\sqrt[3]{3}\ldots\ldots+\sqrt[n]{n}}{n}$ $= 1$

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(a) 0 (b) ~~1~~

(c) 2 (d) -1

$\lim_{n\to\infty} n^{1/n} = 1$

Note : The converse of this theorem may not be true

$\langle a_n \rangle = \langle (-1)^n \rangle$

$$\frac{a_1 + a_2 \cdots a_n}{n} = \frac{-1 + 1 - 1 + 1 - \cdots (-1)^n}{n}$$

$$= \begin{cases} 0 & \text{if } n \text{ is even} \\ \frac{1}{n} & \text{if } n \text{ is odd} \end{cases}$$

0

$$\lim_{n \to \infty} \frac{a_1 + a_2 \cdots a_n}{n} = 0$$

$\lim_{n \to \infty} a_n = 0$ ✗

(2) Cauchy's Second theorem : Let $<a_n>$ be a sequence of real number and $\lim_{n\to\infty} a_n = l$ Then $\lim_{n\to\infty}(a_1.a_2.....a_n)^{\frac{1}{n}} = l$

$$\lim_{n\to\infty}\left[\frac{2}{1}\left(\frac{3}{2}\right)^2\left(\frac{4}{3}\right)^3\cdots\left(\frac{n+1}{n}\right)^n\right]^{1/n} = e$$

$$\lim_{n\to\infty}\left(\frac{n+1}{n}\right)^n = \lim_{n\to\infty}\left(1+1/n\right)^n = e$$

Q2. Find the limit of $\left[(1)(2)^{\frac{1}{2}}(3)^{\frac{1}{3}}\ldots\ldots\ldots(n)^{\frac{1}{n}}\right]^{\frac{1}{n}}$

(a) 0 (b) 1

(c) -1 (d) 2

$\lim_{n\to\infty}(n)^{1/n}=1$

(3) Let < a_n> be sequence of real number and $a_n>0$; $\forall\ n\in N$

Then $\lim\limits_{n\to\infty}\dfrac{a_{n+1}}{a_n} = l \Rightarrow \lim\limits_{n\to\infty}(a_n)^{\frac{1}{n}} = l$; $l > 0$

$$\frac{a_1+a_2+\dots+a_n}{n}$$

$$\lim_{n\to\infty}\frac{1}{n}\left[(n+1)(n+2)\cdots(n+n)\right]^{1/n} = 4$$

$$\lim_{n\to\infty}\left(\frac{(n+1)(n+2)\cdots(n+n)}{n^n}\right)^{1/n}$$

$$\lim_{n\to\infty}\frac{(n+2)(n+3)\cdots(2n+2)}{(n+1)^{n+1}}\cdot\frac{n^n}{(n+1)(n+2)\cdots(n+n)}$$

$$\lim_{n\to\infty}\frac{(2n+1)(2n+2)\,n^n}{(n+1)^n(n+1)(n+1)}$$

$$\lim_{n\to\infty}\frac{4n^2\left(1+\frac{1}{2n}\right)\left(1+\frac{1}{n}\right)}{n^n\left(1+\frac{1}{n}\right)^n n^2\left(1+\frac{1}{n}\right)^2} = 4/e$$

NOTE : The converse of this theorem is not true

$$\langle a_n \rangle = \frac{3+(-1)^n}{2}$$

$$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = 1$$

$$a_n = \begin{cases} 2 & n - \text{even} \\ 1 & n - \text{odd} \end{cases}$$

$$\frac{a_{n+1}}{a_n} = \left(\frac{3+(-1)^{n+1}}{2}\right)\left(\frac{2}{3+(-1)^n}\right)$$

$$(a_n)^{1/n} = \begin{cases} 2^{1/n} & n - \text{even} \\ 1^{1/n} & n - \text{odd} \end{cases} = 1$$

$$\lim_{n\to\infty} (a_n)^{1/n} = 1$$

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FOUNDATION COURSE OF
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Q3. $\lim_{n\to\infty} \frac{(n!)^{\frac{1}{n}}}{n}$ Which of following is true

(a) e ~~(b) 1/e~~

(c) e^2 (d) $1/e^2$

$$\lim_{n\to\infty} \left(\frac{n!}{n^n}\right)^{1/n}$$

$$a_n = \frac{n!}{n^n}$$

$$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = \lim_{n\to\infty} \frac{(n+1)!}{(n+1)^{n+1}} \cdot \frac{n^n}{n!} = \lim_{n\to\infty} \frac{\cancel{(n+1)}\, n^n}{\cancel{(n+1)}\,(n+1)^n}$$

$$= \lim_{n\to\infty} \frac{\cancel{n^n}}{\cancel{n^n}\,(1+1/n)^n} = \frac{1}{e}$$

Q4. $L = \lim_{n\to\infty} \frac{1}{\sqrt[n]{n!}}$ Then which of the following is true

(a) $L = 0$ (b) $L = 1$

(b) $0 < L < \infty$ (d) $L = \infty$

CSIR NET JUNE 2017

$\lim_{n\to\infty} \left(\frac{1}{n!}\right)^{1/n}$

$a_n = \frac{1}{n!}$

$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = \lim_{n\to\infty} \frac{1}{(n+1)!} \cdot \frac{n!}{1}$

$= \lim_{n\to\infty} \frac{\cancel{n!}}{(n+1)\cancel{n!}} = \underline{0}$

Q

$\langle S_K \rangle$

$S_K = K^{\frac{a}{K}}, \quad K \geq 1, \; a > 0$

$\lim_{n \to \infty} (S_1 S_2 \cdots S_n)^{1/n} = \lim_{n \to \infty} S_n$

$\lim_{n \to \infty} n^{a/n} = \left(n^{\frac{1}{n}}\right)^a$

$= 1^a$

$= 1$

(a) 0 (b) 1

(c) -1 (d) 2

$\langle x_n \rangle$ is monotonic and bounded

~~(a) ∃ a subseq. of $\langle x_n \rangle$ which divg.~~

~~(b) ∃ a sub seq of $\langle x_n \rangle$ which is not monotonic~~

(c) All subseq. of $\langle x_n \rangle$ are converge to same limit

~~(d) ∃ at least two sub seq. of $\langle x_n \rangle$ which is diverge to distinct limit.~~

$\langle x_n \rangle$ be an unbounded seq in $\mathbb{R}$

(a) $\langle x_n \rangle$ has convergent sub seq.

(b) $\langle x_n \rangle$ has subseq. $\langle x_{n_k} \rangle$ s.t $x_{n_k} \to 0$

(c) $\langle x_n \rangle$ has a sub seq. $\langle x_{n_k} \rangle$ s.t $\frac{1}{x_{n_k}} \to 0$

(d) Every sub seq. of $\langle x_n \rangle$ is unbounded

$\langle n \rangle$

$\langle n \rangle$

$\left\langle \frac{1}{x_{n_k}} \right\rangle$

$\langle 0, 1, 0, 2, 0, 3, 0, 4, 0, 5 \ldots \rangle$

Q5 . $L=\lim\limits_{n\to\infty}\left\{\dfrac{(3n)!}{(n!)^3}\right\}^{\frac{1}{n}}$ Then which of the following is true

$a_n = \dfrac{(3n)!}{(n!)^3}$

(a) L = 0 (b) L = 3

(c) L = 27 (d) L = 30

$$\lim_{n\to\infty}\frac{a_{n+1}}{a_n} = \lim_{n\to\infty}\frac{(3n+3)!}{((n+1)!)^3}\cdot\frac{(n!)^3}{(3n)!}$$

$$= \lim_{n\to\infty}\frac{(3n+3)(3n+2)(3n+1)\cancel{(3n)!}\,\cancel{(n!)^3}}{(n+1)^3\,\cancel{(n!)^3}\,\cancel{(3n)!}}$$

$$= \lim_{n\to\infty}\frac{27\cancel{n^3}\left(1+\frac{1}{n}\right)\left(1+\frac{2}{3n}\right)\left(1+\frac{1}{3n}\right)}{\cancel{n^3}\left(1+\frac{1}{n}\right)^3}$$

$$= 27$$

(4) Let $<a_n>$ be a sequence of real number such that

$$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = l \quad \text{Where} |l| < 1 \text{ then } \lim_{n\to\infty} a_n = 0$$

(5) Let $<a_n>$ be a sequence of real number such that

$$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = l \quad \text{Where} |l| > 1 \text{ Then } \lim_{n\to\infty} a_n = \infty$$

Q7 : $$\lim_{n\to\infty}\frac{1}{\sqrt{n}}\left[\frac{1}{\sqrt{1}+\sqrt{3}}+\frac{1}{\sqrt{3}+\sqrt{5}}+\ldots\frac{1}{\sqrt{2n-1}+\sqrt{2n+1}}\right]$$

equals **CSIR NET JUNE 2014**

(a) $\sqrt{2}$

(b) $\frac{1}{\sqrt{2}}$

(c) $\sqrt{2}+1$

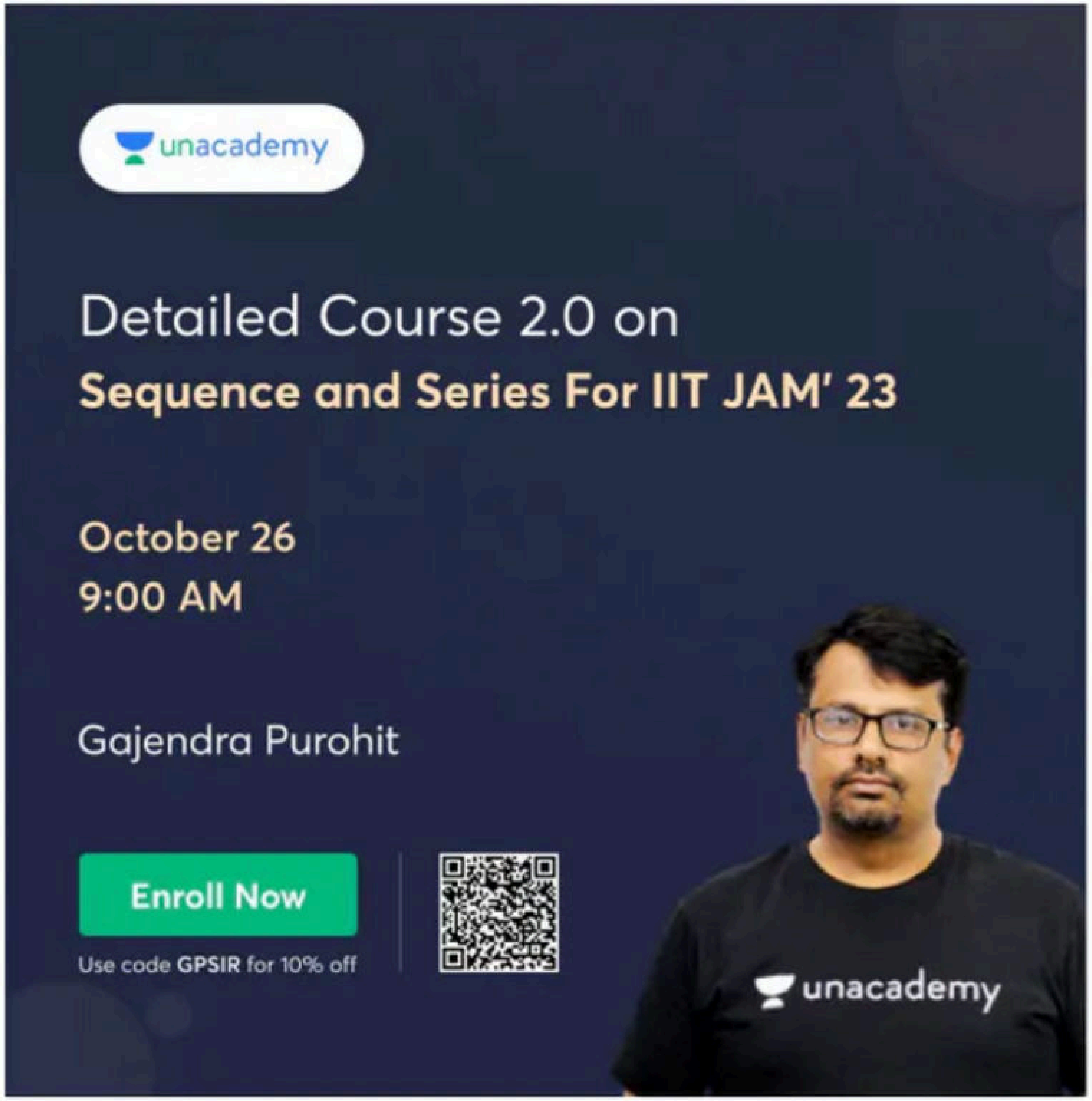
(d) $\frac{1}{\sqrt{2}+1}$

Q8 : $$\lim_{n\to\infty}\frac{1}{\sqrt{n}}\left[\frac{1}{\sqrt{2}+\sqrt{4}}+\frac{1}{\sqrt{4}+\sqrt{6}}+\ldots\ldots\frac{1}{\sqrt{2n}+\sqrt{2n+2}}\right]$$

CSIR NET DEC 2015

(a) $\sqrt{2}$ (b) $\frac{1}{\sqrt{2}}$

(c) $\sqrt{2}+1$ (d) $\frac{1}{\sqrt{2}+1}$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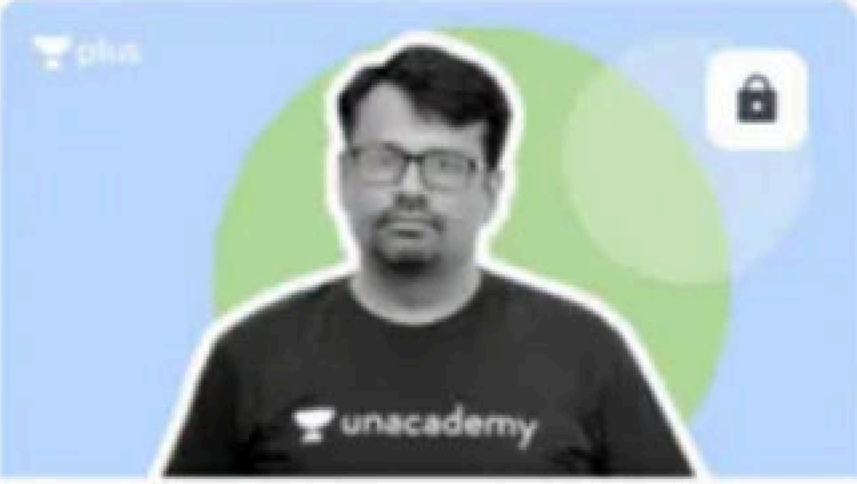

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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- Lives in **Udaipur, Rajasthan, India**
- Unacademy Educator since

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