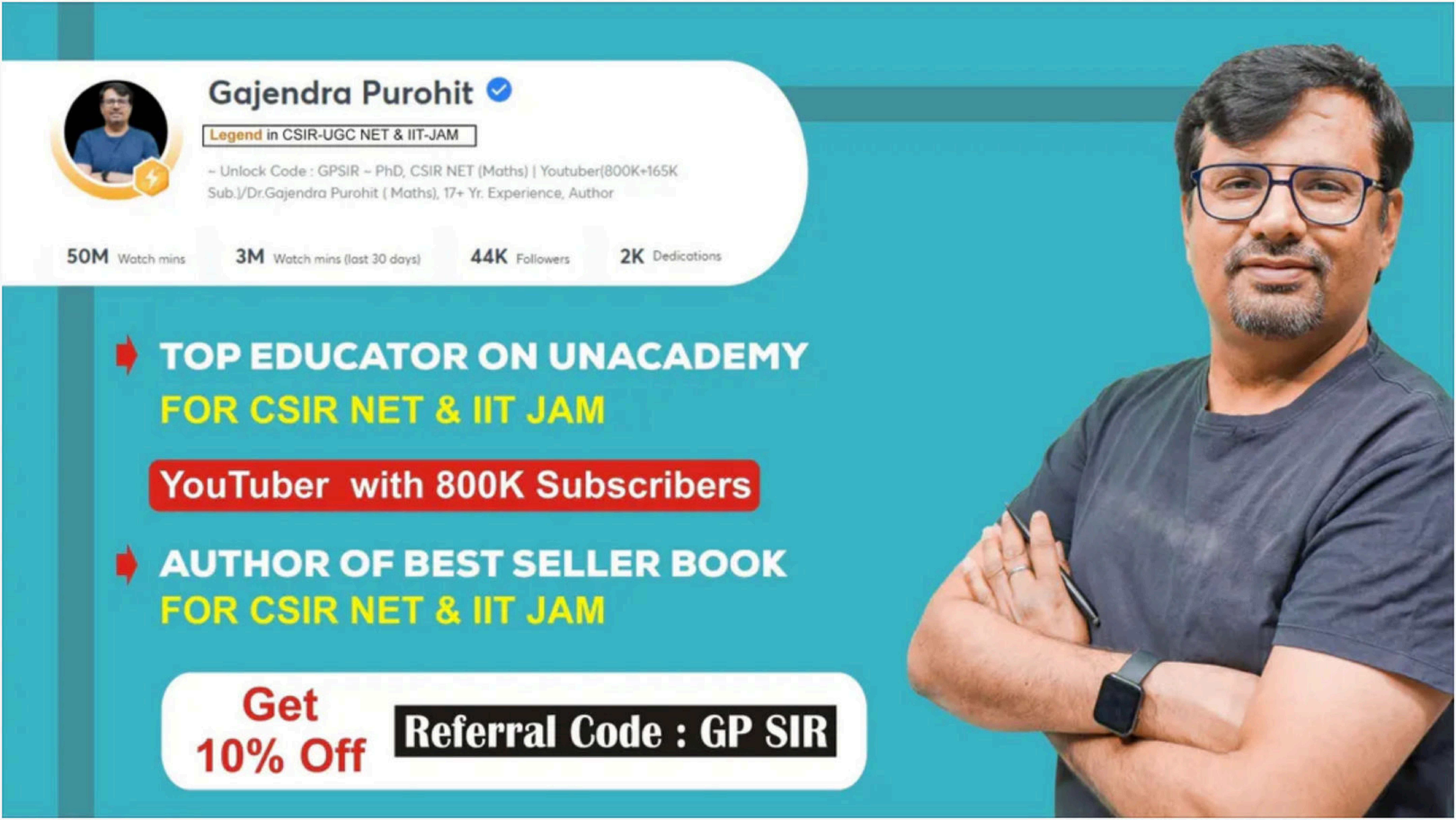
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Limit inferior and limit superior of sequence :

Let $\langle a_n \rangle$ be a sequence of real number then limit superior and limit inferior are denoted by $\overline{\lim_{n\to\infty}}\, a_n$ and $\underline{\lim_{n\to\infty}}\, a_n$.

Case – 1 : If sequence is convergent Then $\overline{\lim_{n\to\infty}}\, a_n = \underline{\lim_{n\to\infty}}\, a_n = l = \lim_{n\to\infty} a_n$

Case – 2 : If sequence is divergent. There arise two cases.

(a) If sequence is unbounded above,

Then $\overline{\lim_{n\to\infty}} a_n = \underline{\lim}_{n\to\infty} a_n = \infty$

(b) If sequence is unbounded below, Then,

$$\overline{\lim_{n\to\infty}} a_n = \underline{\lim}_{n\to\infty} a_n = -\infty.$$

Case – 3 : If sequence is oscillatory. There arise again two cases.

(a) If sequence is finitely oscillate :

Let $\langle a_n \rangle$ be a finitely oscillate sequence and P be the set of all limit points.

Then $\overline{\lim_{n\to\infty}} a_n = \sup P$ and $\underline{\lim_{n\to\infty}} a_n = Inf\ P$.

(b) If sequence is infinitely oscillate :

(i) Let $<a_n>$ be a infinitely oscillate sequence. which is unbounded above and unbounded below then $\overline{\lim\limits_{n\to\infty}} a_n = \infty$ and $\underline{\lim\limits_{n\to\infty}} a_n = -\infty$.

(ii) Let $<a_n>$ is infinitely oscillate sequence which is unbounded above but bounded below.

$$\overline{\lim_{n\to\infty}} a_n = \infty \ \& \ \underline{\lim_{n\to\infty}} a_n = \text{smallest limit point}$$

(iii) Let $<a_n>$ is infinitely oscillate sequence which is unbounded below but bounded above.

$$\overline{\lim_{n\to\infty}} a_n = \text{biggest limit point} \;\&\; \underline{\lim_{n\to\infty}} a_n = -\infty$$

Q1. Let $x_n = n^{\frac{1}{n}}$ and $y_n = e^{1-x_n}$, $n \in N$. then which of the following is true

(a) $\limsup y_n = \liminf y_n = 0$

(b) $\limsup y_n \neq \liminf y_n$

(c) $\limsup y_n = \liminf y_n = 1$

(d) $\limsup x_n = \liminf y_n$

Q.2. Consider the sequence < a_n > ,

where $a_n = 3 + 5\left(-\frac{1}{2}\right)^n + (-1)^n\left(\frac{1}{4} + (-1)^n \frac{2}{n}\right)$

then the interval $\left(\lim_{n\to\infty}\inf a_n, \lim_{n\to\infty}\sup a_n\right)$

(a) (-2 , 8)

(b) $\left(\frac{11}{4}, \frac{13}{4}\right)$

(c) (3 , 5)

(d) $\left(\frac{1}{4}, \frac{7}{4}\right)$

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Q3. Consider the sequence $a_n = \left[1+(-1)^n \frac{1}{n}\right]^n$, then

(a) $\lim \sup a_n = \lim \inf a_n = 1$

(b) $\lim \sup a_n = \lim \inf a_n = e$

(c) $\lim \sup a_n = e$, $\lim \inf a_n = 1/e$

(d) $\lim \sup a_n = \lim \inf a_n = 1/e$

Q4. Let $a_n = \begin{cases} 2+\dfrac{(-1)^{\frac{n-1}{2}}}{n} & if \quad n \text{ is odd} \\ 1+\dfrac{1}{2^n}; & if \quad n \text{ is even} \end{cases}$. then which of the following are true?

(a) sup $\{a_n \mid n \in N\} = 3$ & inf $\{a_n \mid n \in N\} = 1$

(b) lim inf a_n = lim sup $a_n = 3/2$

(c) sup $\{a_n \mid n \in N\} = 2$ and inf $\{a_n \mid n \in N\} = 1$

(d) lim inf $a_n = 1$ & lim sup $a_n = 3$

Q5. Let $< a_n > = 1 + \frac{(-1)^n}{n}, n \in N$, then which of the following is/are true.

(a) $<a_n>$ is finitely oscillatory sequence.

(b) $<a_n>$ is convergent sequence

(c) $\overline{\lim_{n\to\infty}} a_n \neq \underline{\lim}_{n\to\infty} a_n$

(d) $<a_n>$ is divergent sequence.

Q7. The limit inferior of the sequence $<a_n>$, where $<a_n> = 1 + (-1)^n + \frac{1}{3^n}$.

(a) 1 (b) 2

(c) 3 (d) 0

Q8. If $<a_n> = 1 + (-1)^n + \sin\frac{1}{n}$ then

(a) $<a_n>$ is convergent sequence

(b) $\lim\sup a_n \neq \lim\inf a_n$

(c) $\lim\sup a_n = \lim\inf a_n$

(d) $\lim\sup a_n = 2$

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

Example : Let $< a_n > = < (-1)^n >$ then $<|a_n|> = < 1 >$

Here $\lim|a_n| = 1$ but limit a_n does not exist

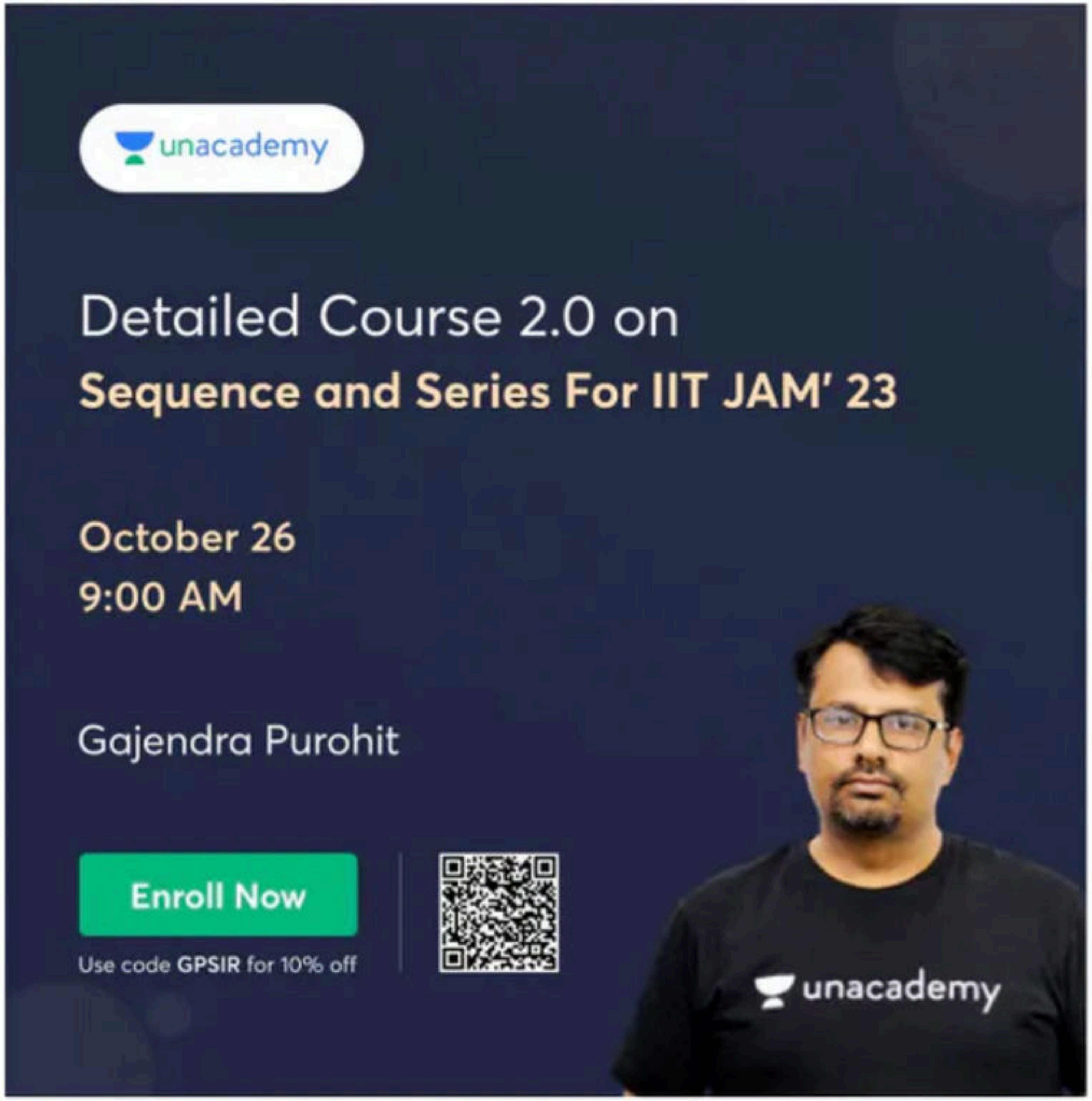
(2) **Cauchy's First Theorem :** Let $< a_n >$ be a sequence of real numbers and $\lim\limits_{n\to\infty} a_n = l$ then $\lim\limits_{n\to\infty} \frac{a_1 + a_2 + \ldots\ldots + a_n}{n} = l$

Q.9. Find the Limit of $\dfrac{1+\sqrt{2}+\sqrt[3]{3}........+\sqrt[n]{n}}{n}$ **CSIR NET 2022**

(a) 1 (b) 2

(c) 3 (d) 4

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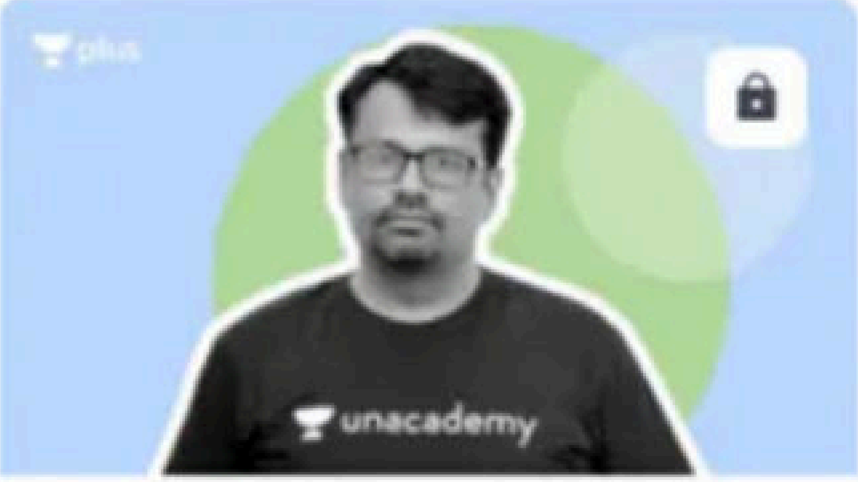

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Educator highlights

- 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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