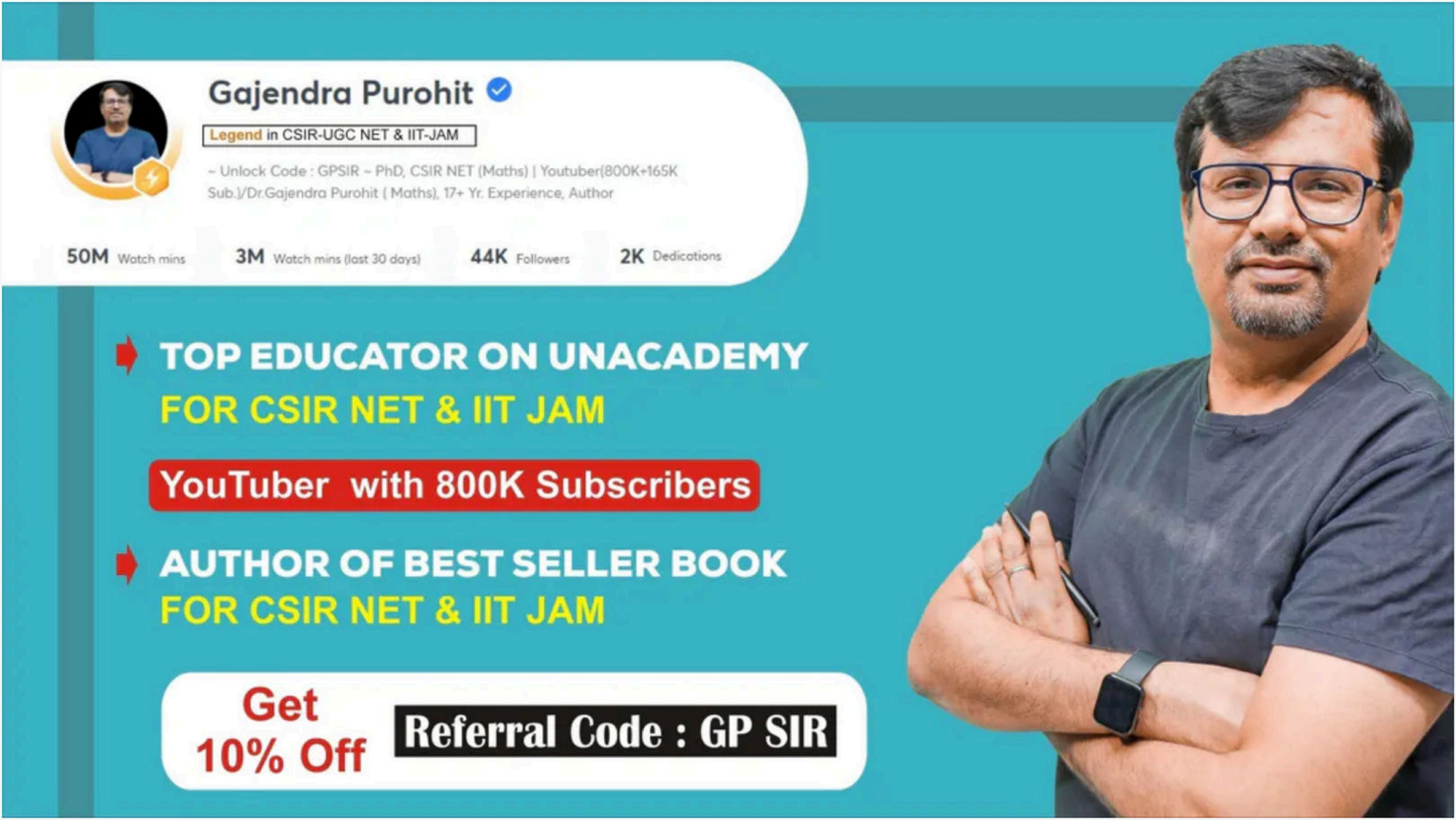
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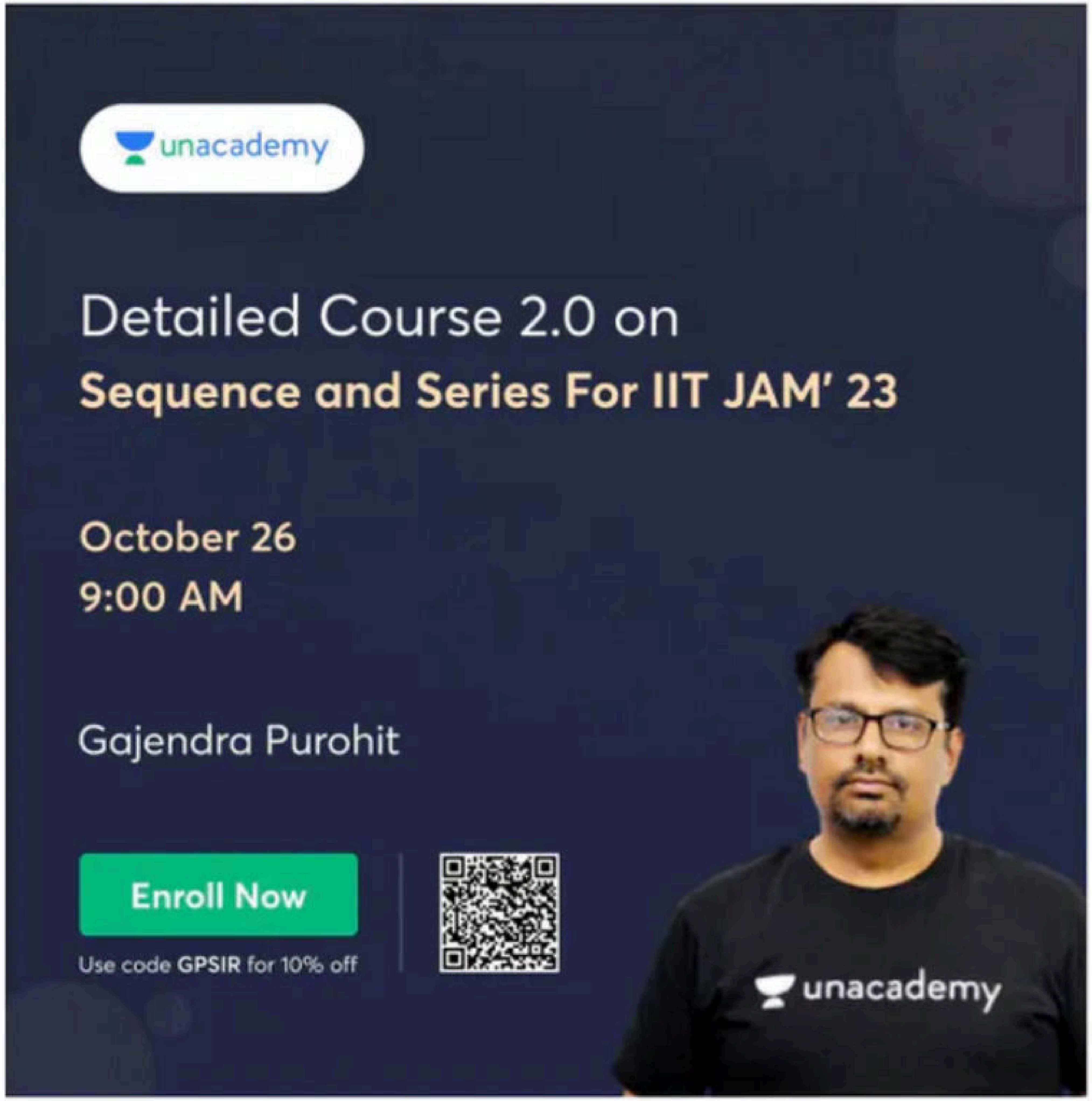
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$\int_1^{\infty} \frac{1}{x^2}\,dx$

$\sum_{n=1}^{\infty} \frac{1}{n}$

$\int_1^{\infty} \frac{1}{x}\,dx$

$(\log x)_1^{\infty}$

$(\log \infty - \log 1)$

∞

$\sum_{n=1}^{\infty} \frac{1}{n^2}$

$-\left(\frac{1}{x}\right)_1^{\infty}$

$= -\left(\frac{1}{\infty} - \frac{1}{1}\right)$

-1

$$\sum_{n=1}^{\infty} \frac{1}{n^2+1}$$

$$\int_1^{\infty} \frac{1}{x^2+1}\,dx = \left(\tan^{-1} x\right)_1^{\infty}$$

$$= \tan^{-1}\infty - \tan^{-1} 1$$

$$= \pi/2 - \pi/4$$

$$= \pi/4$$

Q3 . The convergence for series $\sum_{n=1}^{\infty} \frac{1}{n(\log n)}$. is

(a) Convergent (b) Divergent

(b) Oscillatory (d) None of these

$$\int_1^{\infty} \frac{1}{x \log n}\, dn$$

$$\int_0^{\infty} \frac{1}{t}\, dt$$

$$(\log t)_0^{\infty}$$

$$\infty$$

$$2^n \frac{1}{\cancel{2^n} \log 2^n}$$

$$\frac{1}{n \log 2} = \frac{1}{\log 2} \sum \frac{1}{n}$$

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A series of the form $u_1 - u_2 + u_3 - u_4 + \ldots\ldots$ where $u_n > 0$ for all $n \in N$ is an alternating series and is denoted by

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

$$1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \cdots$$

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

$$1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots$$

$$\sum_{n=1}^{\infty}(-1)^{n-1}\frac{1}{n^2}$$

$$\frac{3}{2} - \frac{4}{3} + \frac{5}{4} - \cdots = \sum_{n=2}^{\infty} (-1)^n \left(\frac{n+1}{n}\right)$$

$$1 - \frac{2^2}{2!} + \frac{3^3}{3!} - \cdots \qquad \sum_{n=1}^{\infty} (-1)^{n-1} \frac{n^n}{n!}$$

Important Test For Convergence of Alternating Series :

Leibnitz's test : If u_n be a monotone decreasing sequence of positive real numbers and $\lim_{n\to\infty} u_n = 0$ then the alternating series $\sum_{n=1}^{\infty} (-1)^{n+1} u_n$ is convergent.

It is sufficient condition for convergence of alternating series

$\sum_{n=1}^{\infty} (-1)^{n+1} \frac{1}{n}$

$u_n = \frac{1}{n}$

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

$= 0$

$\sum \frac{1}{n}$

$\sum (-1)^n \frac{1}{n}$

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

$$u_n = 1/n^2$$

$$\lim_{n \to \infty} u_n = 0$$

$$\sum (-1)^n \frac{1}{\sqrt{n}}$$

$$= \frac{3}{2} - \frac{4}{3} + \frac{5}{4} - \frac{6}{5} + - \cdots$$

$$= \sum_{n=1}^{\infty} (-1)^n \left(\frac{n+1}{n}\right)$$

$$1 + \frac{1}{n}$$

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

$$\sum_{n=1}^{\infty} (-1)^{n+1} \frac{n^n}{n!}$$

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

$$u_1 = 1$$

$$u_2 = \frac{2^2}{2!} = 2$$

Q.5. Let $a_n = \frac{1}{n\log n}$, $(n \geq 2)$ then

(a) The sequence $\langle a_n \rangle$ is convergent.

(b) The series $\sum_{n=2}^{\infty} a_n$ is convergent.

(c) The series $\sum_{n=2}^{\infty} a_n^{\,2}$ is convergent.

(d) The series $\sum_{n=2}^{\infty} (-1)^n a_n$ is convergent.

$\sum \frac{(-1)^n}{n\log n}$

$\sum \frac{1}{n\log n}$

$\left\langle \frac{1}{n\log n} \right\rangle$

$\sum \frac{1}{n^2(\log n)^2}$

$2^n \quad \frac{1}{(2^n)^2 (\log 2)^2}$

$\frac{1}{\log 2}$ $\quad \sum \frac{1}{n^2 n}$

$\frac{1}{2^n (n\log 2)^2}$

Q.6. Which of the following series is convergent?

(a) $\displaystyle\sum_{n=1}^{\infty} \frac{1}{\sqrt{n+1}-\sqrt{n}}$ $\quad \frac{1}{\sqrt{n}}$

(b) $\displaystyle\sum_{n=1}^{\infty} \frac{\sin(n)}{n^2}$ $\le \sum \frac{1}{n^2}$

(c) $\displaystyle\sum_{n=1}^{\infty} (-1)^n \log n$

(d) $\displaystyle\sum_{n=1}^{\infty} \frac{\log n}{n}$ $\quad 2^n \frac{\log 2^n}{\cancel{2^n}}$

$\lim_{n\to\infty} \log n = 0$

$\log 2 \sum n$

$$\sum_{n=1}^{\infty} 3^n \pi^{-(n+2)}$$

(a) divergent

(b) convergent & sum is $\frac{3}{\pi(\pi-3)}$

(c) convergent & sum is $\frac{3}{\pi^2(\pi-3)}$

(d) none.

$$\frac{1}{\pi^2}\sum\left(\frac{3}{\pi}\right)^n = \frac{3}{\pi}+\left(\frac{3}{\pi}\right)^2+\cdots$$

$$\left(\frac{3}{\pi}\right)\frac{1}{\pi^2}\left(1+\frac{3}{\pi}+\left(\frac{3}{\pi}\right)^2+\cdots\right)$$

$$\frac{3}{\pi}\frac{1}{\pi^2}\left(\frac{1}{1-\frac{3}{\pi}}\right)$$

$$\frac{3}{\pi}\frac{1}{\pi^2}\left(\frac{1}{1-3/\pi}\right)$$

$$\frac{3}{\cancel{\pi}}\frac{1}{\pi^2}\left(\frac{\cancel{\pi}}{\pi-3}\right)$$

$$\frac{3}{\pi}<1$$

Q.7. Which of the following series is/are convergent?

(a) $\sum_{n=1}^{\infty}(-1)^{n-1}\frac{n^2}{(n+1)!}$

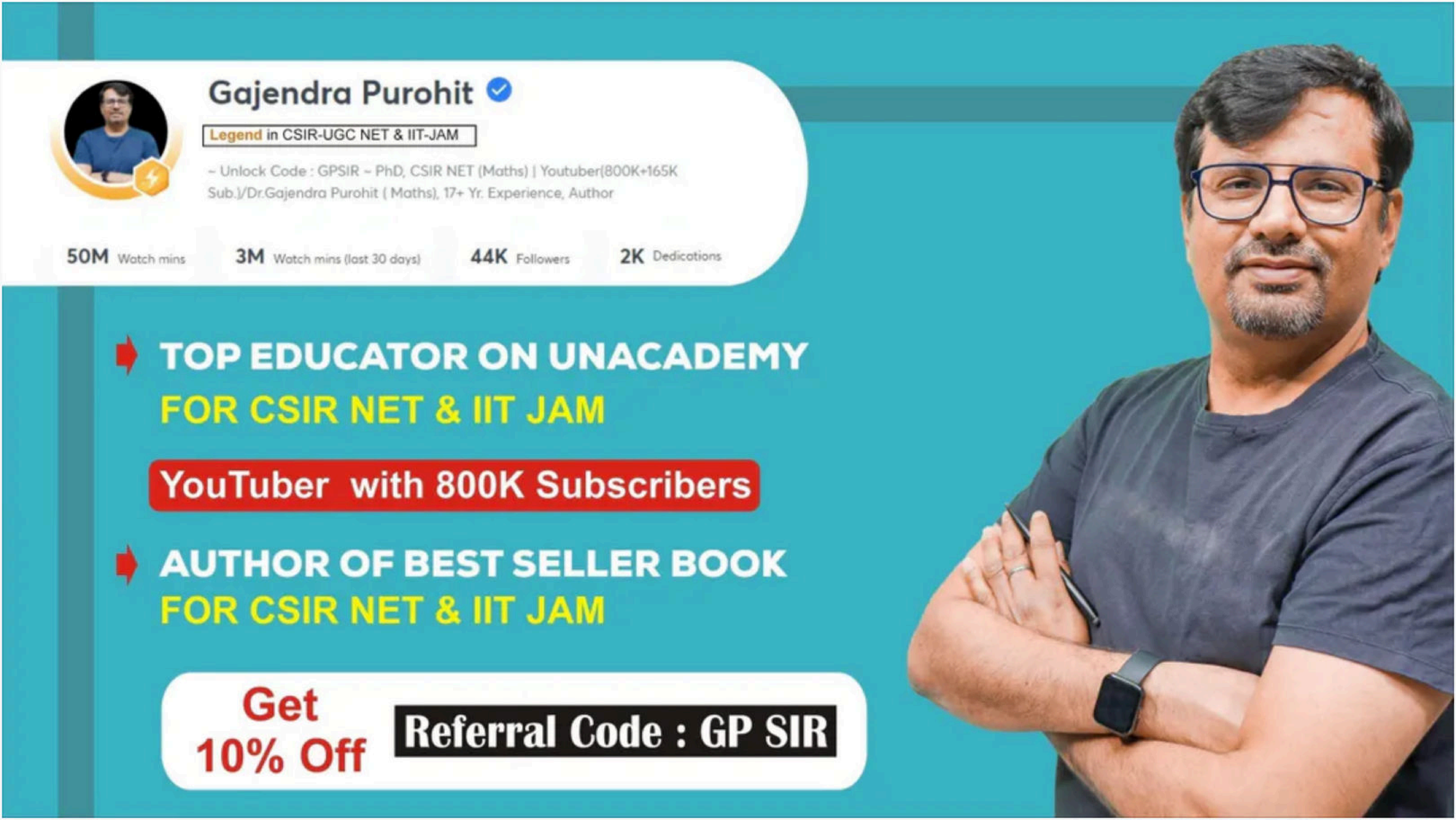
(b) $\sum_{n=1}^{\infty}(-1)^{n}\frac{\log n}{n^2}$

(c) $\sum_{n=1}^{\infty}(-1)^{n}\frac{n^2}{\log n}$

(d) None of these

$\frac{n^2}{(n+1)\,n\,(n-1)!}$ $\qquad$ $\frac{n+1-1}{(n+1)(n-1)!}$

$(-1)^n\frac{n+1}{(n+1)(n-1)!}$ $\qquad$ $\frac{-(-1)^n}{(n+1)(n-1)!}$



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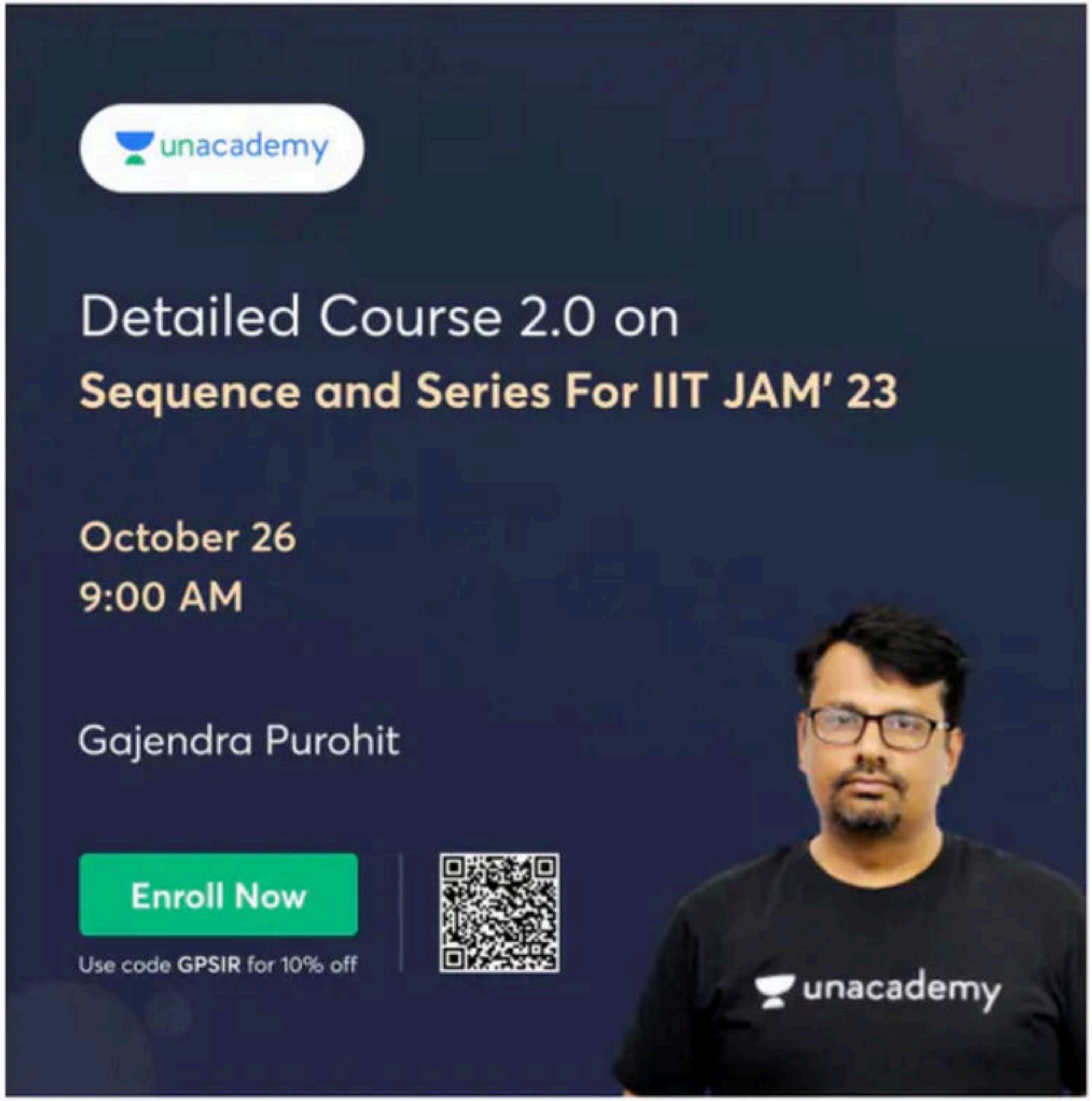
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(d) None of these

Absolutely convergent series :

Let $\sum u_n$ be a alternating series if $\sum |u_n|$ is convergent, then $\sum u_n$ is said to be an absolutely convergent series.

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

Convergent –

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

$$\sum_{n=1}^{\infty} |a_n| = \sum_{n=1}^{\infty} \frac{1}{n}$$

Conditionally Convergent.

$$\sum_{n=1}^{\infty} \frac{(-1)^n}{n^2}$$

Convergent

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

$$\sum_{n=1}^{\infty} |a_n| = \sum_{n=1}^{\infty} \frac{1}{n^2}$$

Absolute Convergent –

Conditionally convergent series :

Let $\sum_{n=1}^{\infty} u_n$ be a alternating series then it is called conditionally convergent series if $\sum_{n=1}^{\infty} u_n$ is convergent series but it is not absolutely convergent series.

Result :

1. Every absolutely convergent series is convergent.

Q1. If $s_n = \dfrac{(-1)^n}{2^n+3}$ and $t_n = \dfrac{(-1)^n}{4n-1}$; n = 0 ,1 ,2 …… then

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(a) $\sum_{n=1}^{\infty} s_n$ is absolutely convergent

(b) $\sum_{n=1}^{\infty} t_n$ is absolutely convergent

(c) $\sum_{n=1}^{\infty} s_n$ is conditionally convergent

(d) $\sum_{n=1}^{\infty} t_n$ is conditionally convergent

$\sum \frac{1}{4n-1}$

$\frac{1}{n}$

$\sum \frac{1}{2^n+3}$

$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = \lim_{n\to\infty} \frac{1}{2^{n+1}+3} \cdot \frac{2^n+3}{1}$

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

$= \frac{1}{2} < 1$

Q2. Let $\sum_{n=1}^{\infty} a_n$ and $\sum_{n=1}^{\infty} b_n$ be two series, where

Ab

$a_n = \frac{(-1)^n n}{2^n}$, $b_n = \frac{(-1)^n}{\log(n+1)}$ **IIT JAM 2014**

(a) Both $\sum_{n=1}^{\infty} a_n$ and $\sum_{n=1}^{\infty} b_n$ are absolutely convergent

(b) Both $\sum_{n=1}^{\infty} a_n$ and $\sum_{n=1}^{\infty} b_n$ are conditionally convergent

(c) $\sum_{n=1}^{\infty} a_n$ is absolutely convergent but $\sum_{n=1}^{\infty} b_n$ is conditionally convergent

(d) $\sum_{n=1}^{\infty} b_n$ is absolutely convergent but $\sum_{n=1}^{\infty} a_n$ is conditionally convergent

$\lim_{n\to\infty} \frac{a_{n+1}}{a_n} = \lim_{n\to\infty} \frac{(n+1)}{2^{n+1}} \frac{2^n}{n}$

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

$= \frac{1}{2} < 1$

$\sum \frac{1}{\log(n+1)}$ $\quad u_n = \frac{1}{\log(n+1)}$

$v_n = 1/n$

$\lim_{n\to\infty} \frac{u_n}{v_n}$

$\lim_{n\to\infty} \frac{n}{\log(n+1)} = \lim_{n\to\infty} \frac{1}{\frac{1}{n+1}} = \infty > 1$

Q3. Which of the following series are absolutely convergent?

(a) $\sum_{n=1}^{\infty} \frac{(-1)^n \cos n\alpha}{n\sqrt{n}}; \alpha \in R$

(b) $\sum_{n=1}^{\infty} \frac{(-1)^n \sin n\alpha}{n^3}; \alpha \in R$

(c) $\sum_{n=1}^{\infty} (-1)^n \frac{n}{2^n}$

(d) None of these

$\frac{\cos n\alpha}{n^{3/2}} \leq \frac{1}{n^{3/2}}$

$\frac{\sin n\alpha}{n^3} \leq \frac{1}{n^3}$

$\sum \frac{n}{2^n}$

Result : If a series is not convergent then it will be neither absolutely nor conditionally convergent.

Q4. Let $u_n = \sin\left(\frac{\pi}{n}\right)$ and consider the series $\sum_{n=1}^{\infty} u_n$. Which of the following is/are false? **TIFR – 2010**

(a) $\sum_{n=1}^{\infty} u_n$ is convergent.

(b) $u_n \to 0$ as $n \to \infty$

(c) $\sum_{n=1}^{\infty} u_n$ is divergent

(d) $\sum_{n=1}^{\infty} (-1)^n u_n$ is absolutely convergent.

Q5. If $\sum_{n=1}^{\infty} a_n$ is absolutely convergent, then which of the following is not true?

(a) $a_n \to 0$ as $n \to \infty$

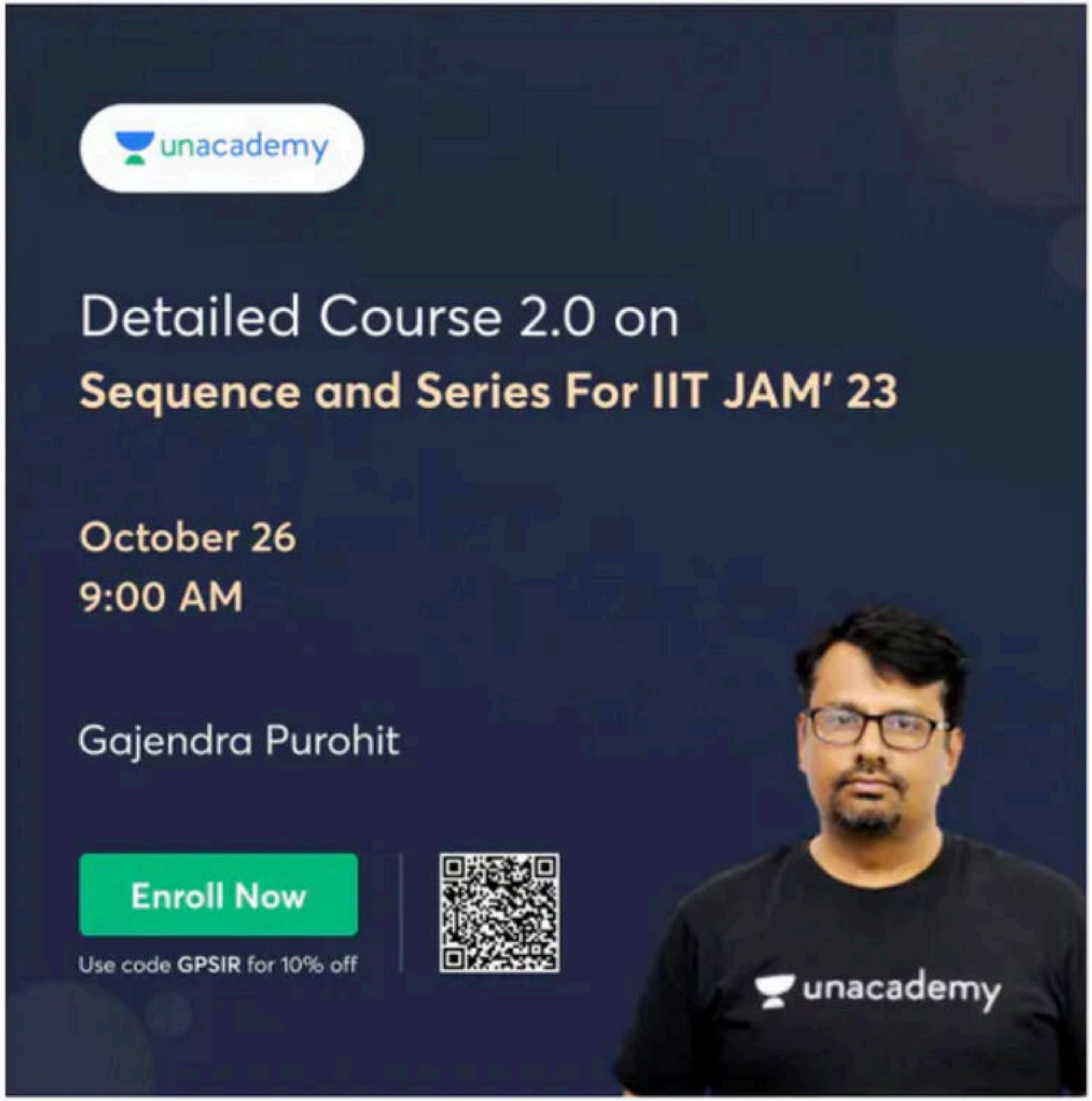
(b) $\sum_{n=1}^{\infty} a_n \sin n$ is convergent

(c) $\sum_{n=1}^{\infty} e^{a_n}$ is divergent (d) $\sum_{n=1}^{\infty} a_n^{\,2}$ is divergent

Q6 Which of the following is/are conditionally convergent?

(a) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{\sqrt{n}}$ (b) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n}$

(c) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^2}$ (d) None of these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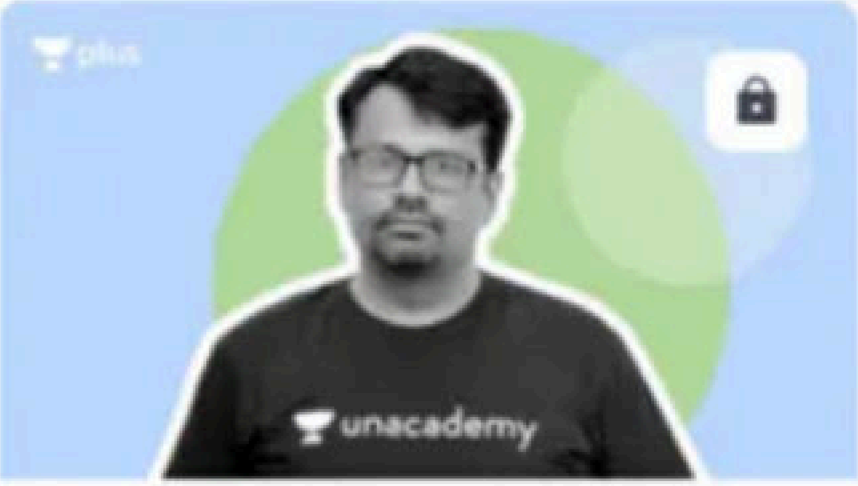

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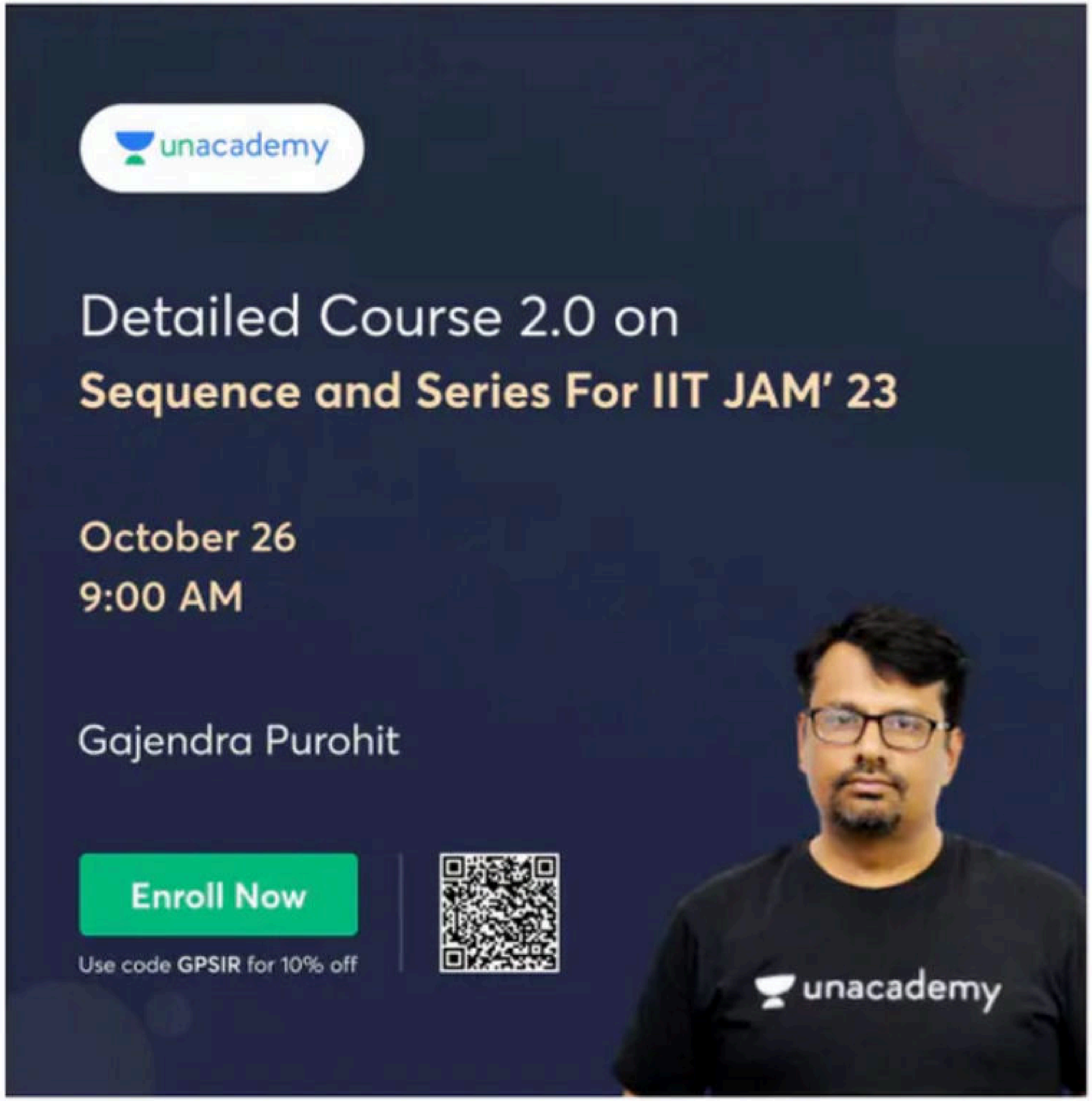
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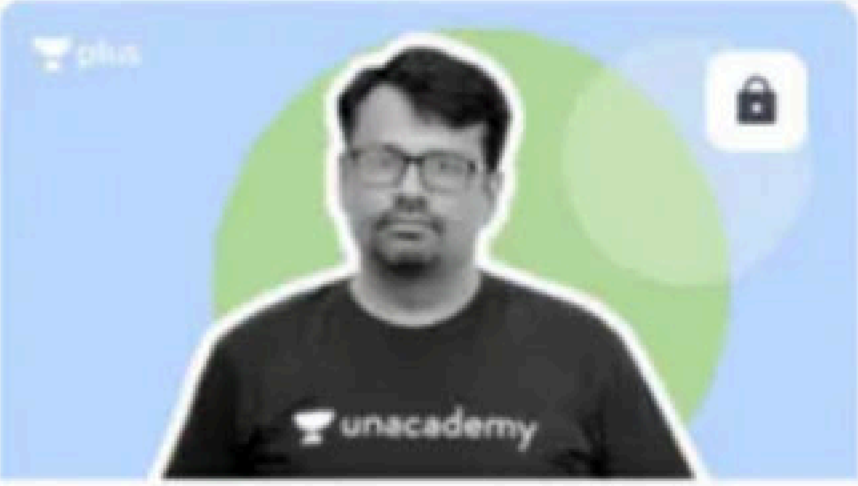

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