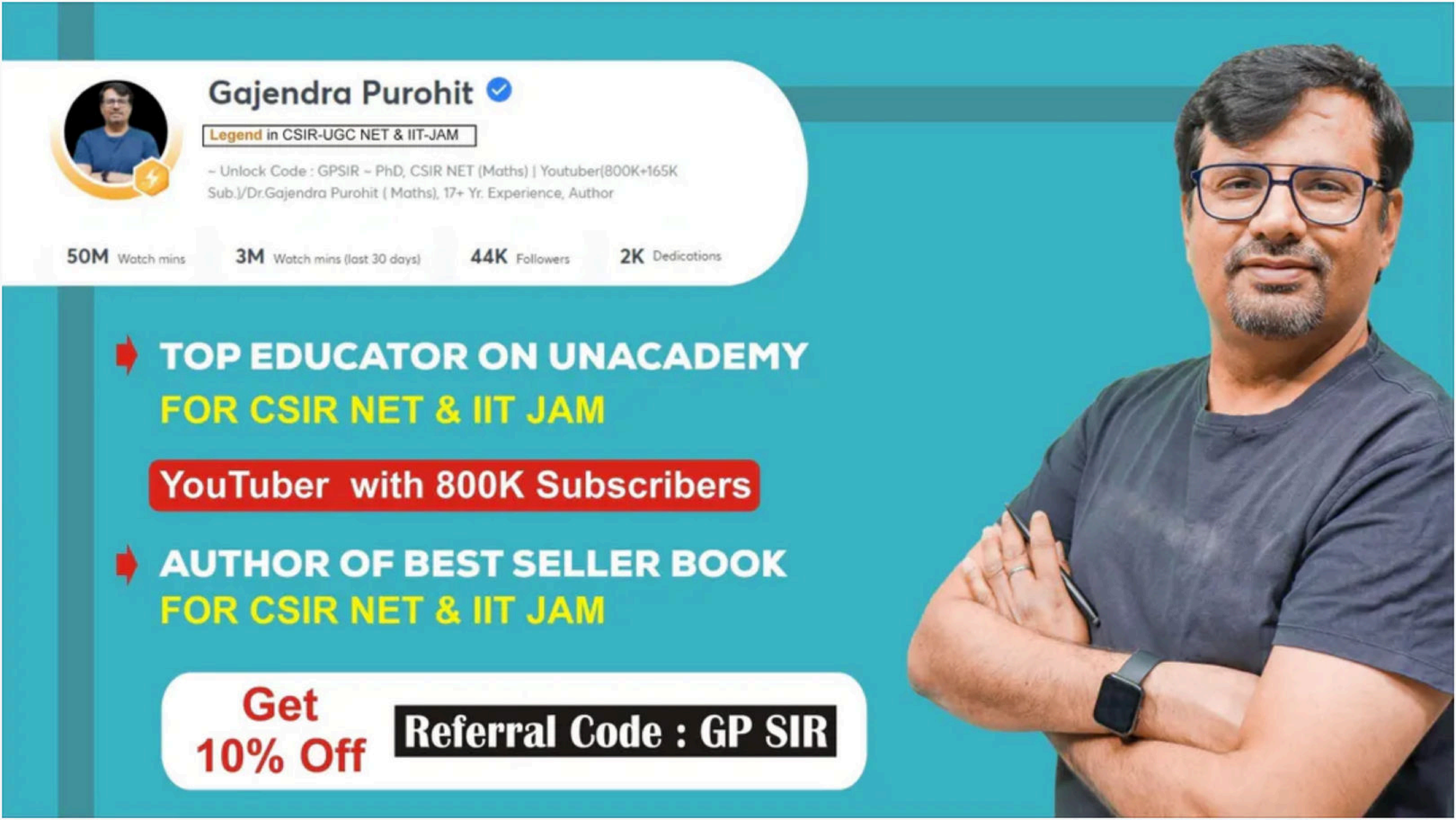
Doubt Clearing Session

Detailed Course 2.0 on Function of One and Several Variable - IIT JAM, 23

Gajendra Purohit • Lesson 8 • Nov 18, 2022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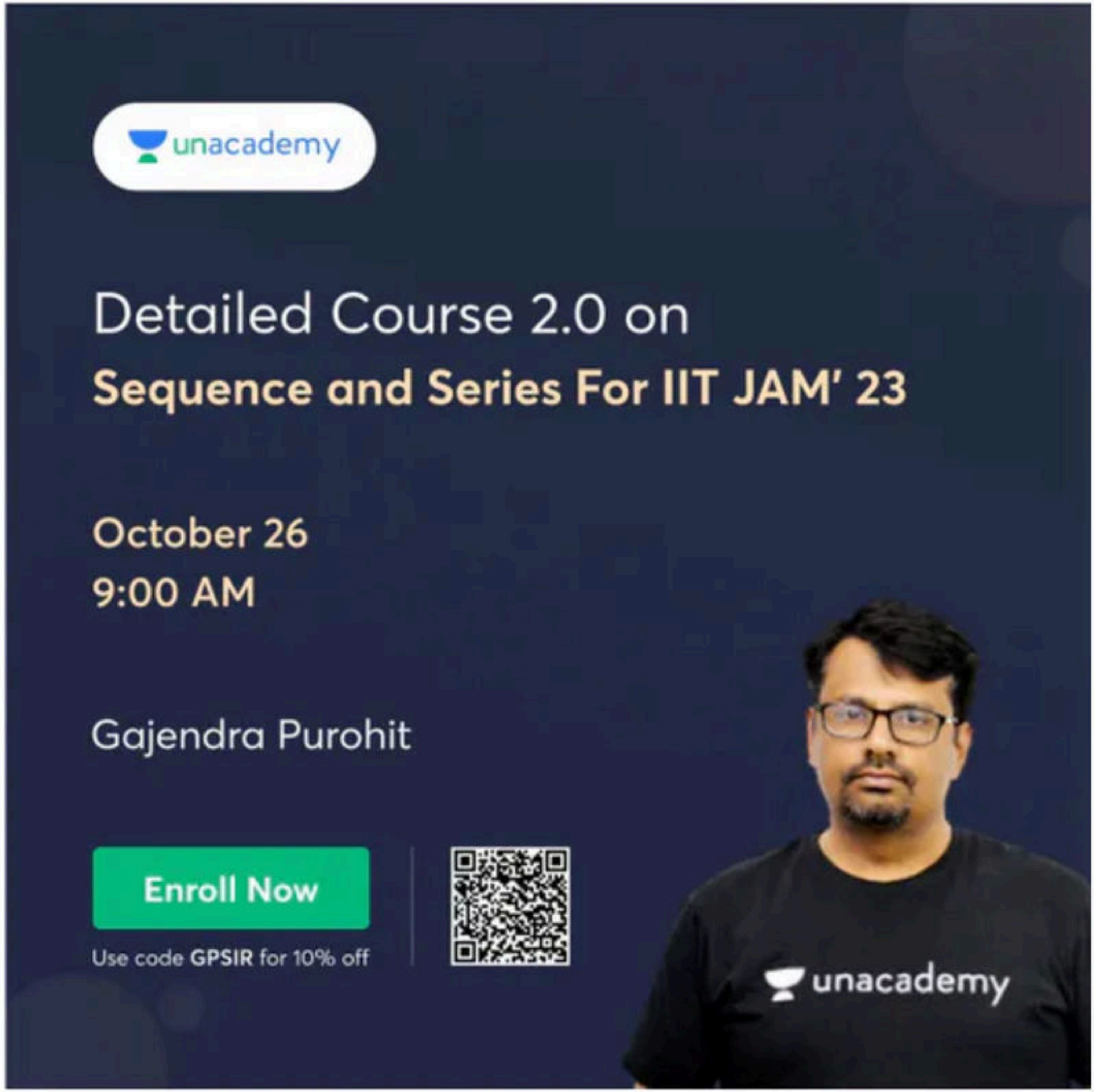
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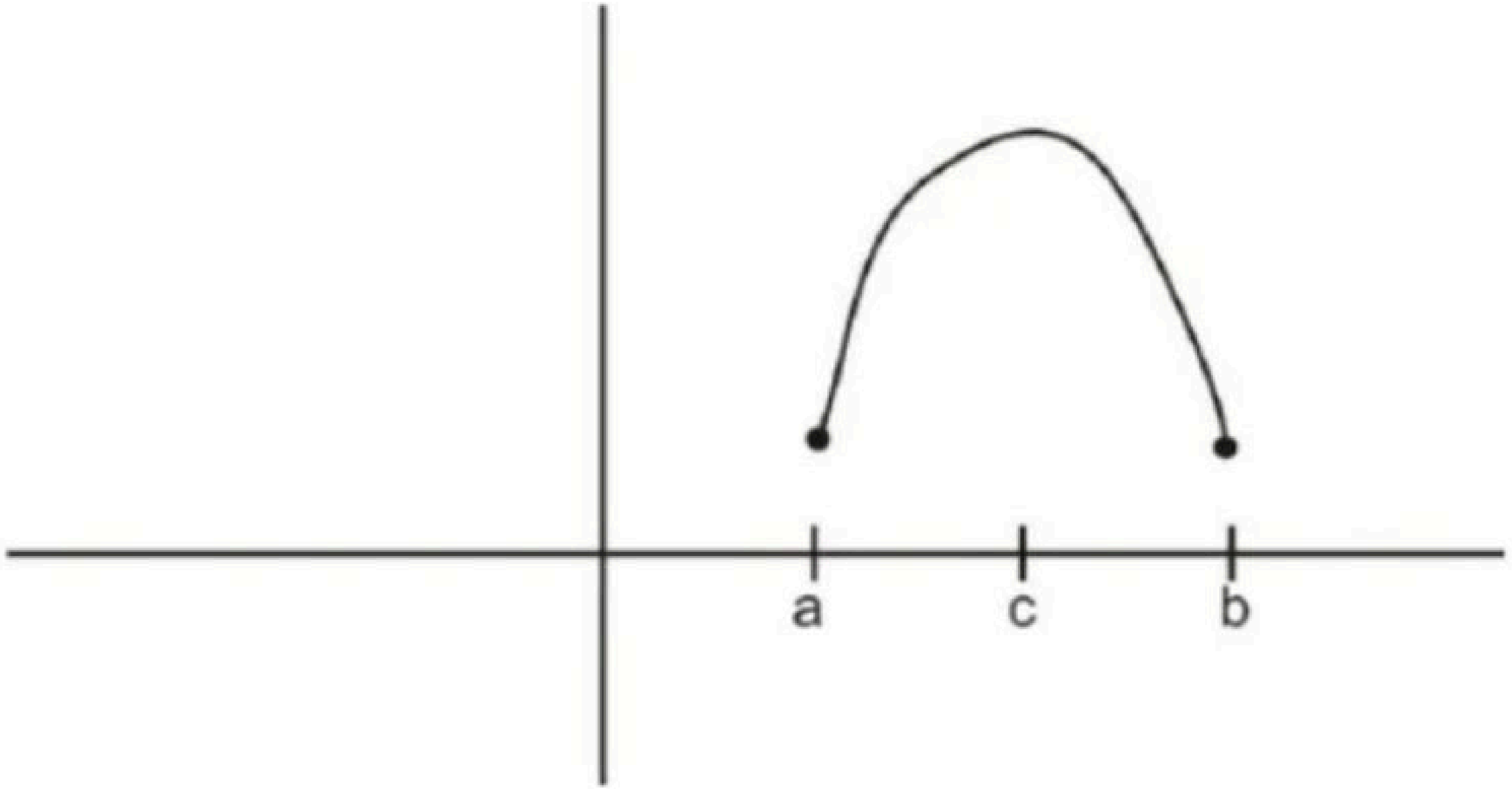
Mean Value Theorem :

(1) **Rolle's Theorem :** Let f be a function defined on [a, b] s.t.

(a) f is continuous on [a, b]

(b) f is differentiable on (a, b)

(c) $f(a) = f(b)$ then $\exists\ c \in (a, b)$ s.t. $f'(c) = 0$



Q.1. If $f(x)=\begin{cases} 1+x & if\ x<0 \\ (1-x)(px+q) & if\ x\geq 0 \end{cases}$ satisfies the assumption of Rolle's theorem in the interval [-1, 1] then the order pair (p, q) is **IIT JAM 2017**

(a) (2, -1) (b) (-2, -1)

(c) (-2, 1) (d) (2, 1)

Q.3. Using Rolle's theorem ,the equation $a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \ldots\ldots + a_n = 0$ has atleast one root between 0 and 1 , If

(a) $\dfrac{a_0}{n} + \dfrac{a_1}{n-1} + \ldots\ldots a_{n-1} = 0$

(b) $\dfrac{a_0}{n-1} + \dfrac{a_1}{n-2} + \ldots\ldots a_{n-2} = 0$

(c) $\dfrac{a_0}{n+1} + \dfrac{a_1}{n} + \ldots\ldots a_n = 0$

(d) $a_0 n + a_1(n-1) + \ldots\ldots a_{n-1} = 0$

Lagrange's mean value theorem (LMVT) :

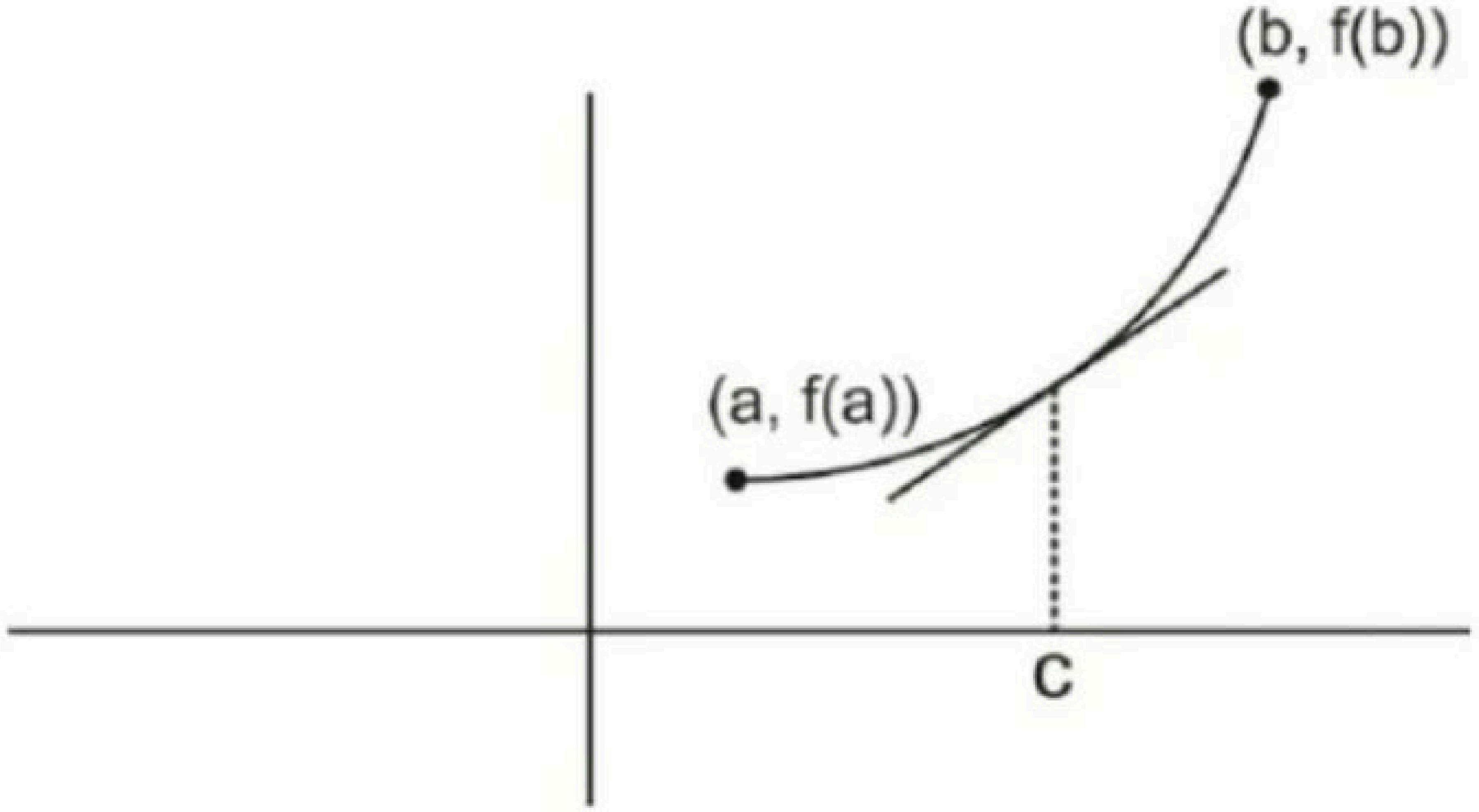
Let f be a function defined on [a, b] s.t.

(i) f is continuous on [a, b]

(ii) f is differentiable on (a, b),

then $\exists$ c $\in$ (a, b)

s.t. $$\frac{f(b)-f(a)}{b-a}=f`(c)$$



Q.3. Let $f : [a, b] \to R$ be a differentiable function. there exist point $c_1, c_2 \in (a, b)$ then which of the following is true **IIT JAM 2005**

(a) $3f(c_1)\, f'(c_1) = f'(c_2)\, [f(a) - f(b)]$

(b) $4f(c_1)\, f'(c_1) = f''(c_2)\, [f(a) + f(b)]$

(c) $5f(c_1)\, f''(c_1) = f'(c_2)\, [f(a) + f(b)]$

(d) $2f(c_1)\, f'(c_1) = f'(c_2)\, [f(a) + f(b)]$

Q.4. For $a, b \in R$ with $a < b$, let $f : [a, b] \to R$ be continuous on $[a, b]$ and twice differentiable on (a, b). Further, assume that the graph of f intersects the straight line segment joining the points $(a, f(a))$ and $(b, f(b))$ at point $(c, f(c))$ for $a < c < b$. Then which of the following is always true **IIT JAM 2012**

(a) There exists a real number $\xi \in (a, b)$ such that $f``(\xi) = 0$

(b) For all real number $\xi \in (a, b)$ such that $f``(\xi) \neq 0$

(c) we can't say

(d) None of these

Cauchy's Mean Value Theorem :

Let f & g be two function defined on [a, b] s.t.

(i) f and g are continuous in [a, b]

(ii) f & g are differentiable in (a, b)

(iii) $g`(x) \neq 0$ for each $x \in (a, b)$ and $g(a) \neq g(b)$.

Then $\exists$ at least one point $c \in (a, b)$ s.t.

$$\frac{f(b)-f(a)}{g(b)-g(a)} = \frac{f'(c)}{g'(c)}$$

Q.5. The value of ξ in the mean value theorem of $f(b) - f(a) = (b - a)f'(\xi)$ for $f(x) = Ax^2 + Bx + C$ in (a, b) is

(a) $b + a$ (b) $b - a$

(c) $\frac{(b+a)}{2}$ (d) $\frac{(b-a)}{2}$

Q.6 A function $f(x) = 1 - x^2 + x^3$ is defined in the closed interval $[-1, 1]$. The value of x, in the open interval $(-1, 1)$ for which the mean value theorem is satisfied is

(a) $-1/2$ (b) $-1/3$

(c) $1/3$ (d) $1/2$

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Taylor's infinite series :

Let n ∈ N , I = [a,b] and f : I → R be a function f , f' , f''….$f^{(n)}$ are continouous on I and that $f^{(n+1)}$ exist on (a , b). then

$$f(x) = f(a) + (x-a)f`(a) + \ldots\ldots \frac{(x-a)^{n-1}}{(n-1)!} f^{(n-1)}(a) + \frac{(x-a)^n}{(n)!} f^{(n)}(a) + ..$$

This is called Taylor's infinite series about x = a.

Maclaurin's infinite series :

In Taylor's series put a = 0.

So, $f(x) = f(0) + xf`(0) + \ldots\ldots \frac{x^n}{n!} f^{(n)}(0)$

which is called Maclaurin's infinite series

Tricks : If $f(x)$ is continuous function and it is vanishes at countably infinte numbers then it will

be identically zero

Q.7. Let S be the set of all continuous function $f : [-1,1] \to R$ satisfying the following three conditions

(i) f is infinitely differentiable on the open interval (-1,1)

(ii) The Taylor's series

$$f(0)+f'(0)x+\frac{f''(0)}{2!}x^2+\ldots\ldots \text{ of f at 0}$$

converges to f(x) for each $x \in (-1,1)$

(iii) $f\left(\frac{1}{n}\right)=0$ for all $n \in N$

Which of the following is true**IIT JAM 2022**

(a) $f(0) = 0$ for all $f \in S$

(b) $f'\left(\frac{1}{2}\right)=0$ for all $f \in S$

(c) $\exists f \in S$ such that $f'\left(\frac{1}{2}\right)\neq 0$

(d) $\exists f \in S$ such that $f(x) \neq 0$ for some $x \in [-1,1]$

Q.8. Let α be the real number such that the coefficient of x^{125} in Maclaurin's series of $(x + \alpha^3)e^x$ is $\dfrac{28}{(124)!}$, then

α **IIT JAM 2020**

(a) 15 (b) 20

(c) 25 (d) 30

Q.9. Let $f(x)=\sqrt{x}+\alpha x$, $x>0$ and $g(x)=a_0+a_1(x-1)+a_2(x-1)^2$ be the sum of the first three terms of the taylor series of f(x) around x = 1. If g(3) = 3, then α is? **IIT JAM 2019**

(a) 1 (b) 1/2

(c) 1/4 (d) 3/4

Q.10. The coefficient of x^2 in the Maclaurin's series expansion of the function $f(x) = xe^x$.

(a) 0 (b) 1

(c) 2 (d) 3


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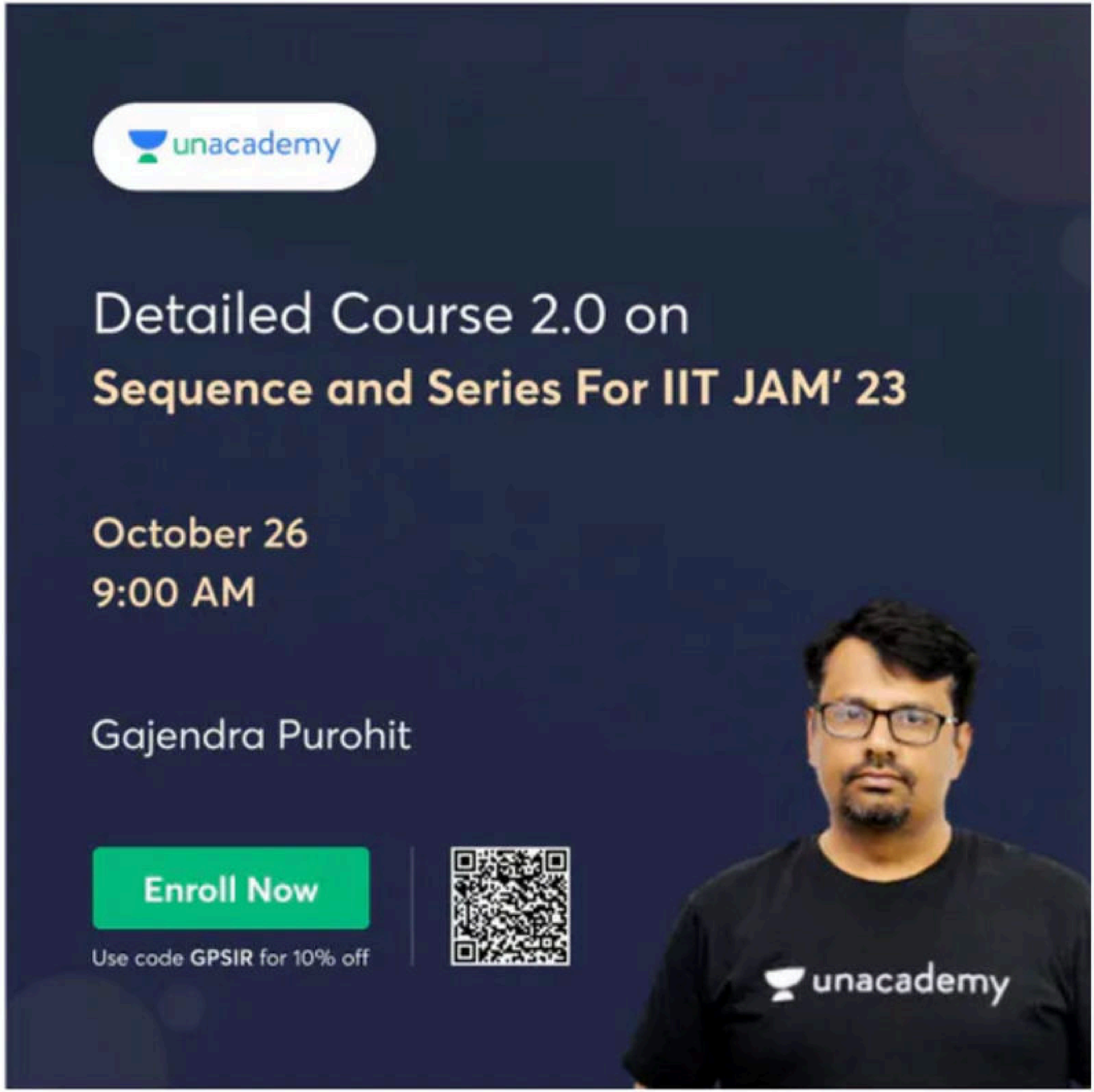
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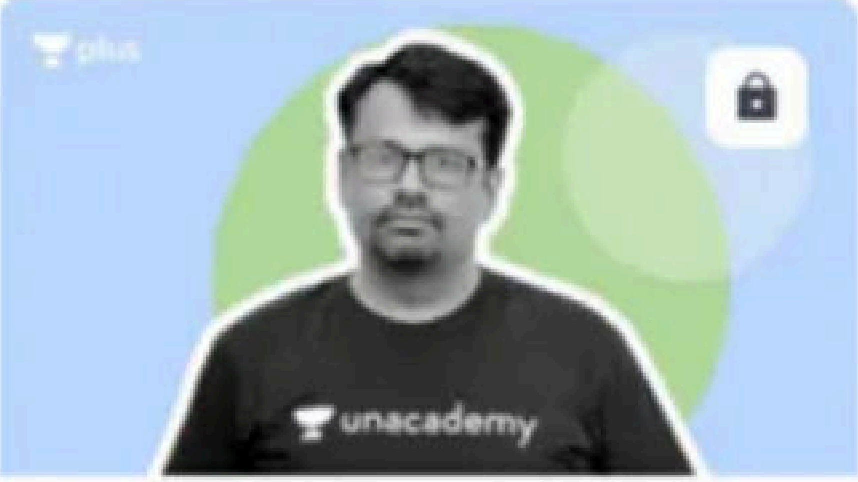

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