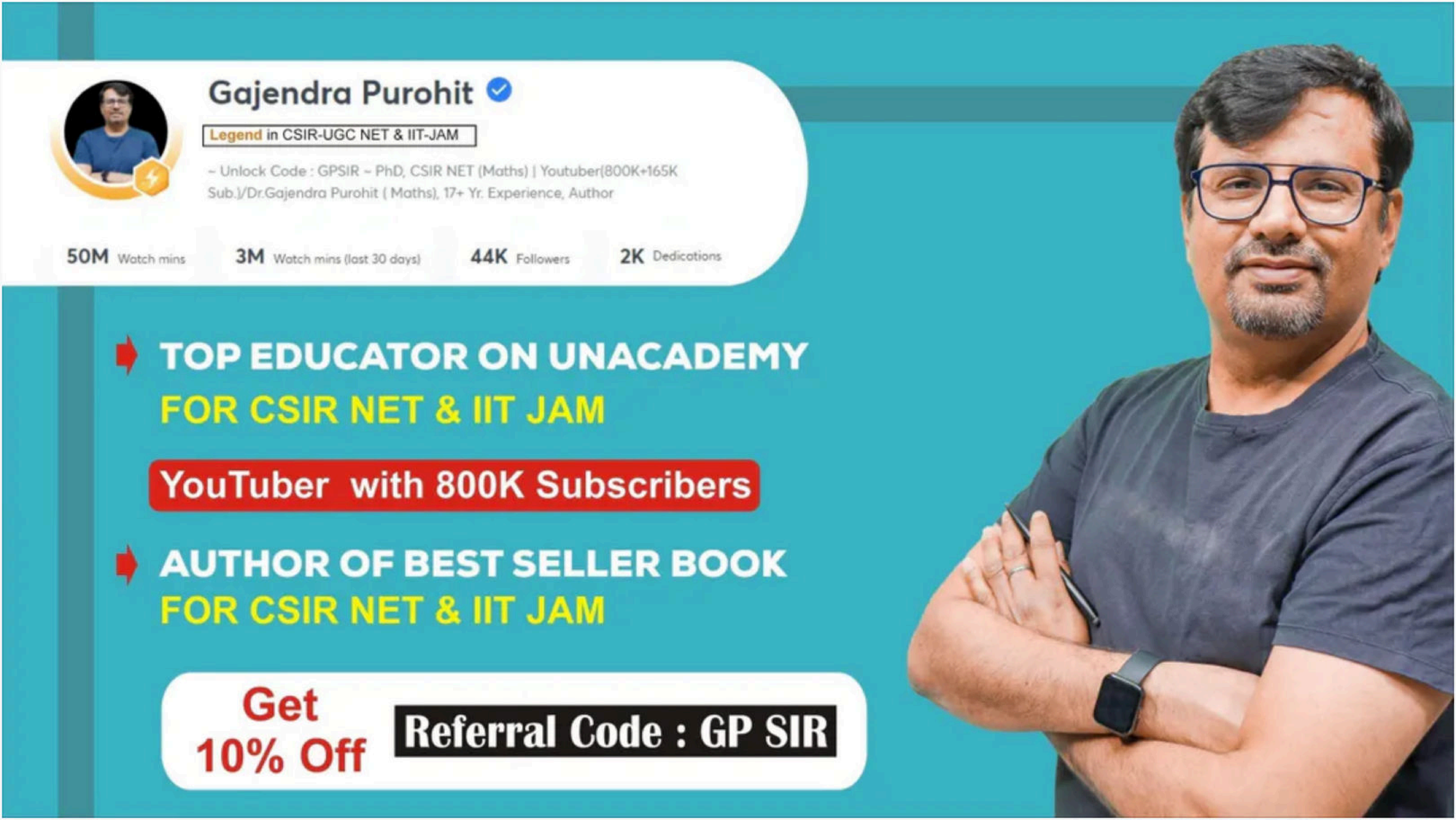
Riemann Integration

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

Gajendra Purohit • Lesson 7 • Nov 17, 2022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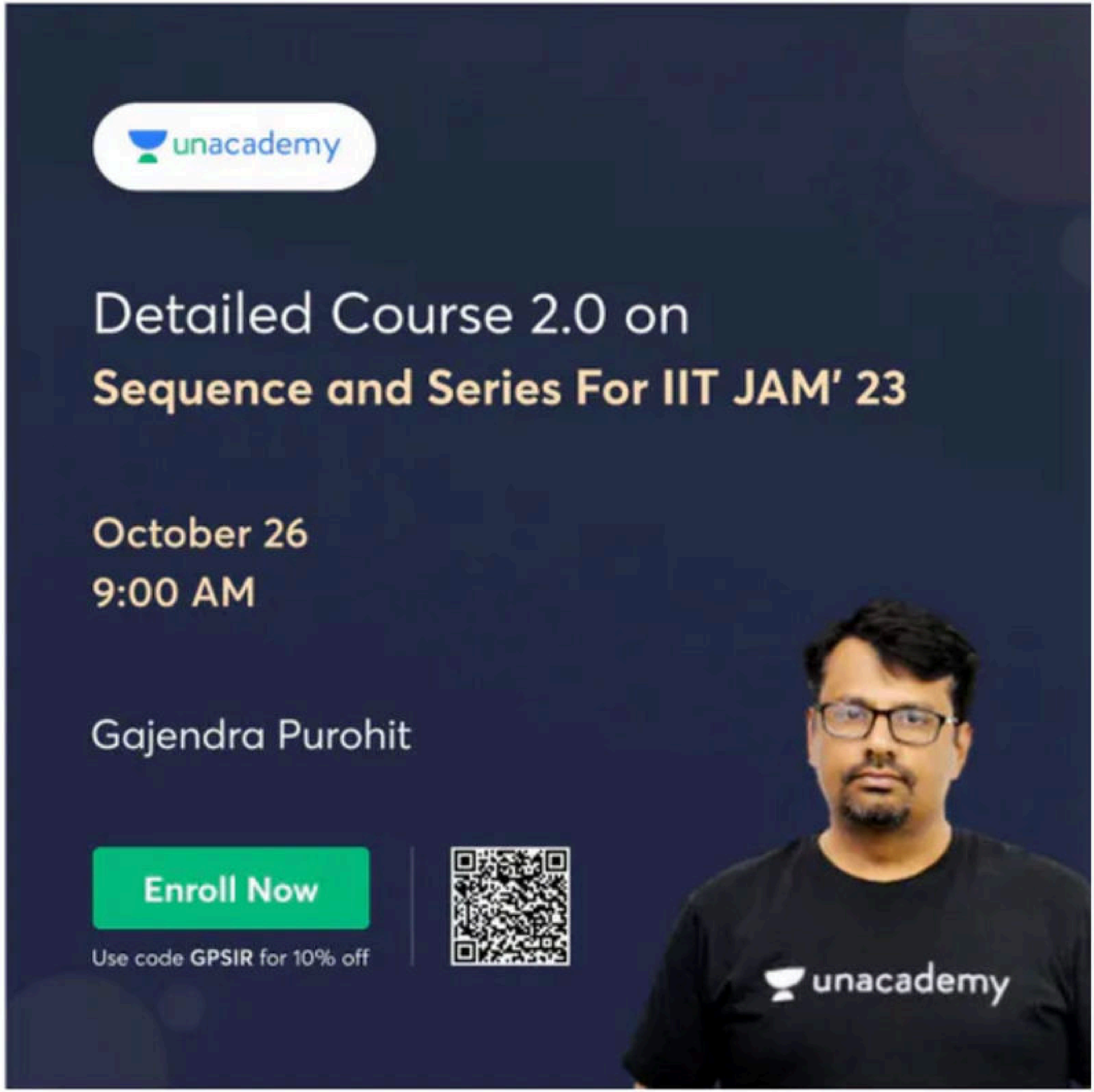
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Differentiability

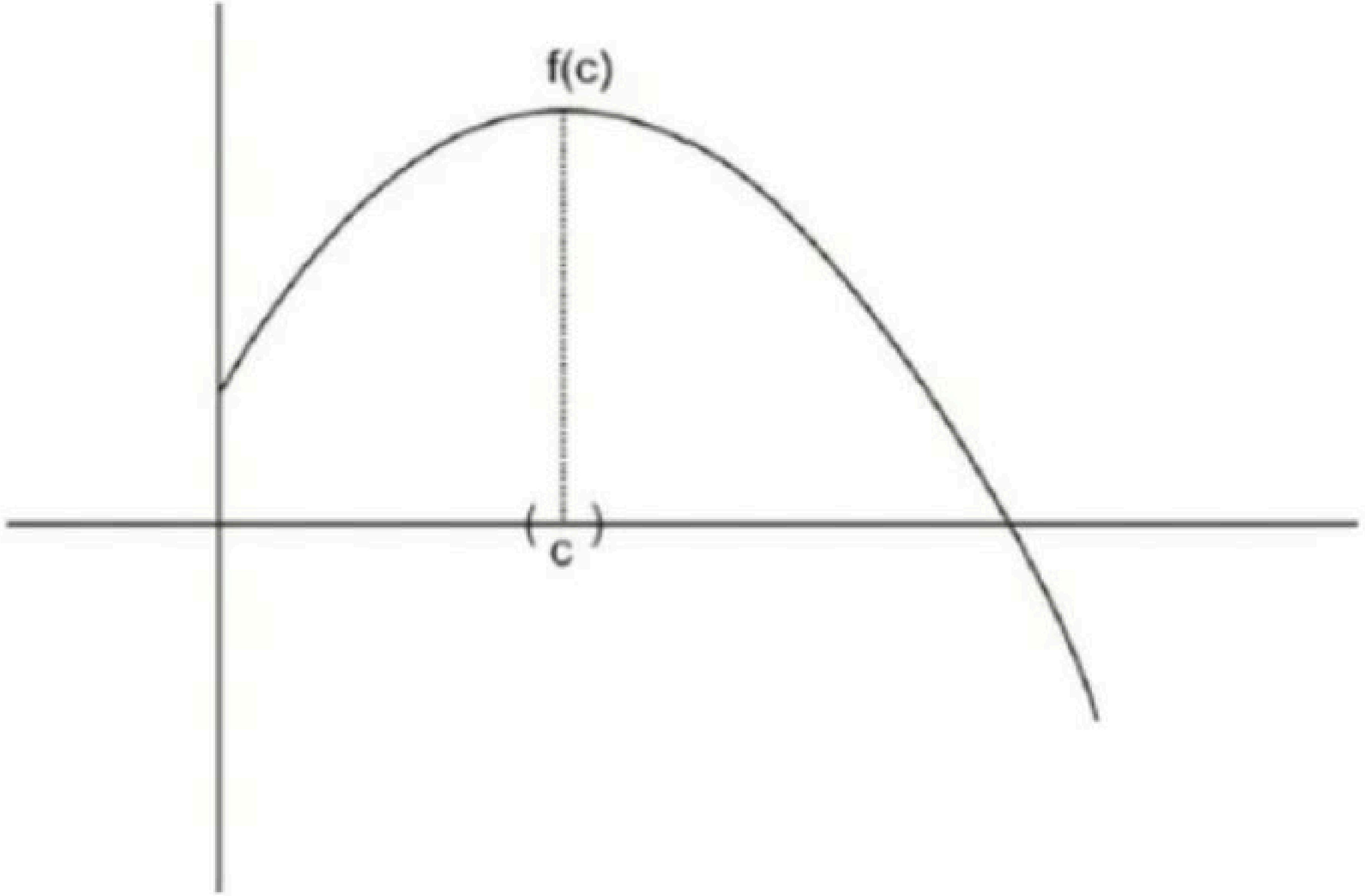
Darboux Theorem :

If a function is differentiable in a closed interval [a, b] and f'(a), f'(b) are of opposite sign, then there exist at least one point c in the open interval (a, b) s.t. f'(c) = 0.

Local maxima and local minima :

Let $f : I \to R$ and c be an interior point of the interval I, then

(i) f(c) is said to be a local maximum value of the function f, if there exist some neighbourhood $(c - \delta, c + \delta)$ of c, such that $f(c) > f(x)$, for all $(c - \delta, c + \delta)$ then c is point of local maxima.



(2) $f(c)$ is said to be local minimum value of the function f, if there exist some neighbourhood of $(c - \delta, c + \delta)$ of c s.t. $f(c) < f(x)$, for all $x \in (c - \delta, c + \delta)$, and c is called point of local minima.

(3) Extreme Value :

f(c) is said to be extreme value of f, if it is either a maximum or minimum value.

i.e. a point x = c is said to be extreme point if f`(c) = 0

Interior extremum theorem :

Let c be the interior point of the interval I at which $f : I \to R$

has an extremum value. If $f'(c) = 0$.

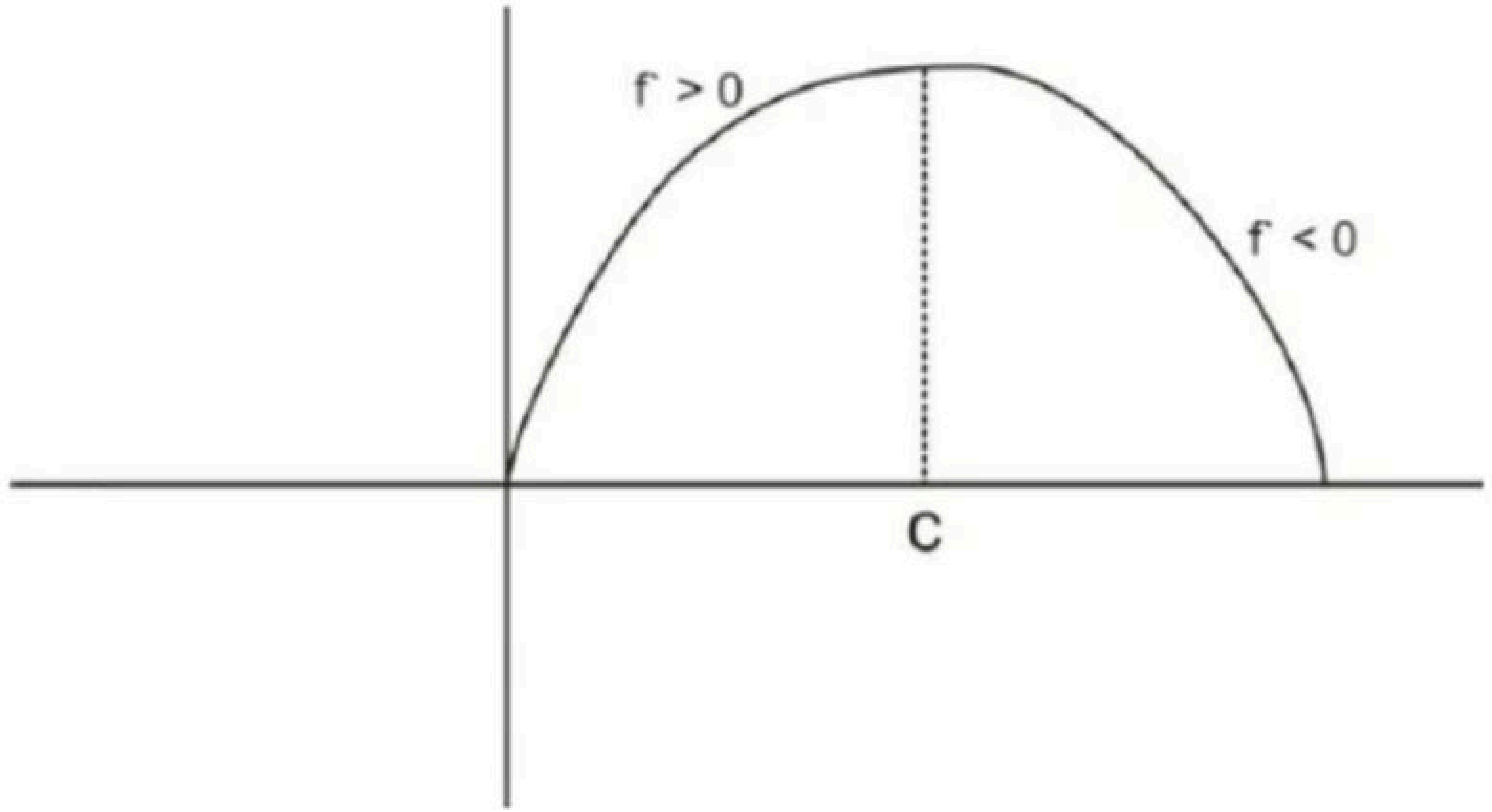
Note :

(1) If $f(x)$ is continuous on $[a, b]$ and $f'(x) > 0$ in (a, b), then $f(x)$ is increasing in $[a, b]$.

(2) If $f(x)$ is continuous in $[a, b]$ and $f'(x) < 0$ in (a, b) then $f(x)$ is decreasing in $[a, b]$.

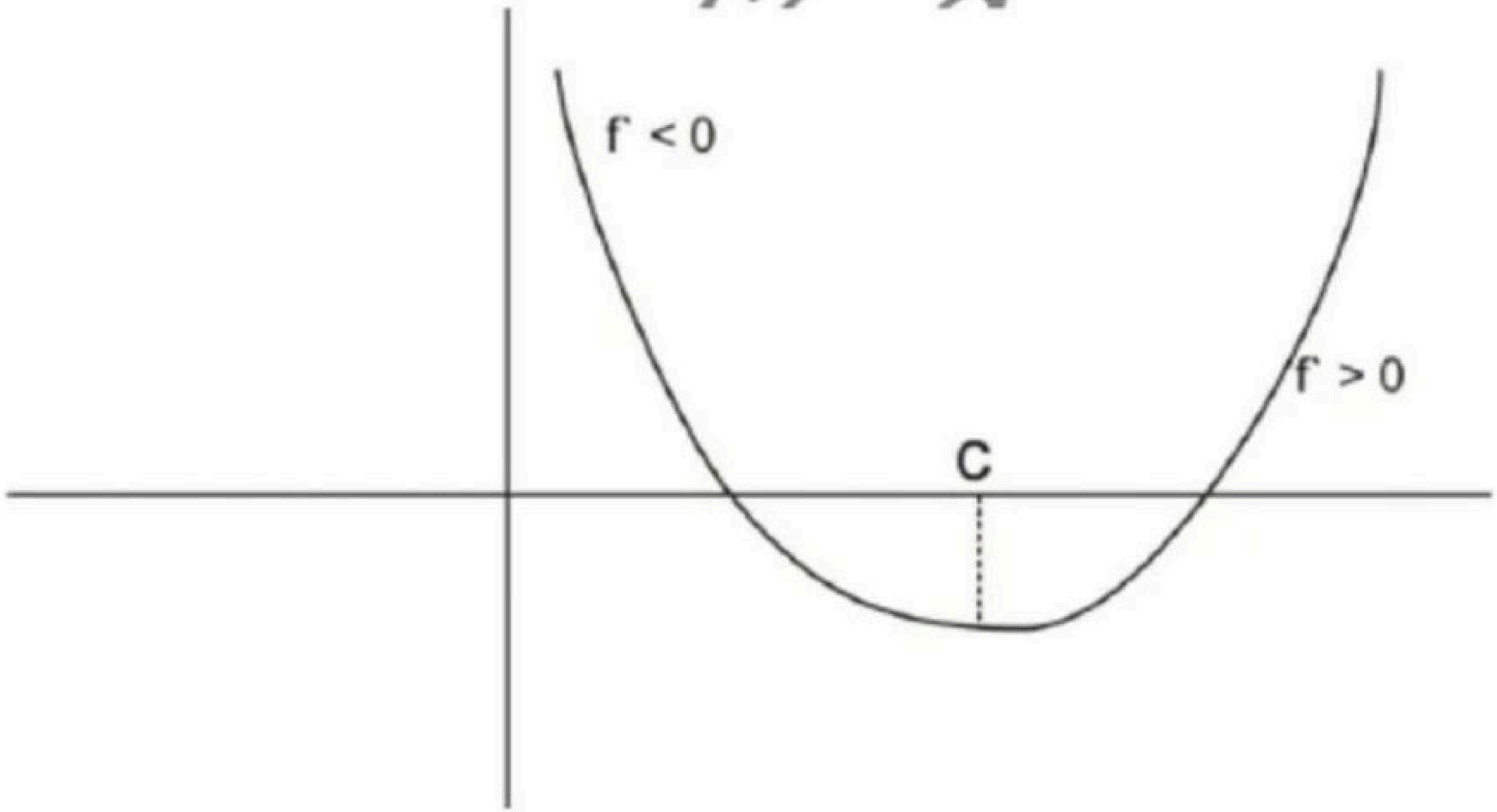
First Derivative test for extreme values :

Let a function f be differentiable in a neighbourhood of c, where f has an extreme value at c, then f(c) is a maximum value if the sign of f` change from positive to negative.



And f(c) is a minimum value of the dign of f` changes from

negative to positive.



Second test for extreme value :

(a) If $f'(c) = 0$ and $f''(c) < 0$ then f has a maximum value at $x = c$.

(b) If $f'(c) = 0$ and $f''(c) > 0$ then f has a minimum value at $x = c$.

Q.1 Let $\varphi : R \to R$ be a differentiable function such that $\varphi`$ is strictly increasing with $\varphi`(1) = 0$. Let α and β denote t he minimum and maximum values of $\varphi(x)$ on the interval [2, 3], respectively. Then which one of the following is TRUE? **IIT JAM 2017**

(a) $\beta = \varphi(3)$ (b) $\alpha = \varphi(2.5)$

(c) $\beta = \varphi(2.5)$ (d) $\alpha = \varphi(3)$

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Q.2. Let $f:\left(0,\frac{\pi}{2}\right)$ be given by f(x) = $(\sin x)^{\pi} - \pi \sin x + \pi$. Then which of the following statements is/are TRUE? **IIT JAM 2019**

(a) f is an increasing function

(b) f is a decreasing function

(c) $f(x) > 0$ for all $x \in \left(0,\frac{\pi}{2}\right)$

(d) $f(x) < 0$ for some $x \in \left(0,\frac{\pi}{2}\right)$

Q.3. Let $f : R \to R$ be a differentiable function with $f(0) = 0$.if for all $x \in R$, $1 < f'(x) < 2$, then which one of the following statements is true on $(0, \infty)$ **IIT JAM 2015**

(a) f is unbounded (b) f is increasing and bounded

(c) f has at least one zero (d) f is periodic

Q.4. For x $\in$ R, let $f(x)=\begin{cases} x^3\sin\left(\frac{1}{x}\right) & x\neq 0 \\ 0 & x=0 \end{cases}$. Then which one of the following is FALSE? **IIT JAM 2017**

(a) $\lim\limits_{x\to 0}\frac{f(x)}{x}=0$ (b) $\lim\limits_{x\to 0}\frac{f(x)}{x^2}=0$

(c) $\frac{f(x)}{x^2}$ has infinitely many maxima and minima on the interval (0,1)

(d) $\frac{f(x)}{x^4}$ is continuous at x = 0 but not differentiable at x = 0.

Q.5. Let $f(x)=\begin{cases} x+x^2\cos\left(\dfrac{\pi}{x}\right) & x\neq 0 \\ 0 & x=0 \end{cases}$ & consider the following statements :

(i) f′(0) exists & is equal to 1

(ii) f is not increasing in any neighbourhood of 0

(iii) f″(0) does not exist

(iv) f is increasing on R

How many of the above statement is/are true?

(a) 0 (b) 1

(c) 2 (d) 3

Q.6. Let $f(x)=\begin{cases} x+1 & x<0 \\ (x-1)^2 & x\geq 0 \end{cases}$

Which one of the following is TRUE?

(a) f is differentiable on R

(b) f has neither a local maximum nor a local minimum in R

(c) f is bounded on R

(d) f is not differentiable at x = 0 and f(x) has local maximum at x = 0

Q.7. If $f : R \to R$ is a continuous function such that $f(x + y) = f(x) + f(y)$ for all $x, y \in R$, then

(a) f is increasing if $f(1) \geq 0$ and decreasing if $f(1) \leq 0$

(b) f is increasing if $f(1) \leq 0$ and decreasing if $f(1) \geq 0$

(c) f is not an increasing function

(d) f is neither an increasing nor a decreasing function

Q.8. Let f be a twice differentiable function on R. Given t hat $f``(x) > 0$ for all $x \in R$, then

(a) $f(x) = 0$ has exactly two solution on R.

(b) $f(x) = 0$ has a positive solution if $f(0) = 0$ & $f`(0) = 0$

(c) $f(x) = 0$ has no positive solution if $f(0) = 0$ and $f`(0) > 0$

(d) $f(x) = 0$ has no positive solution if $f(0) = 0$ and $f`(0) < 0$


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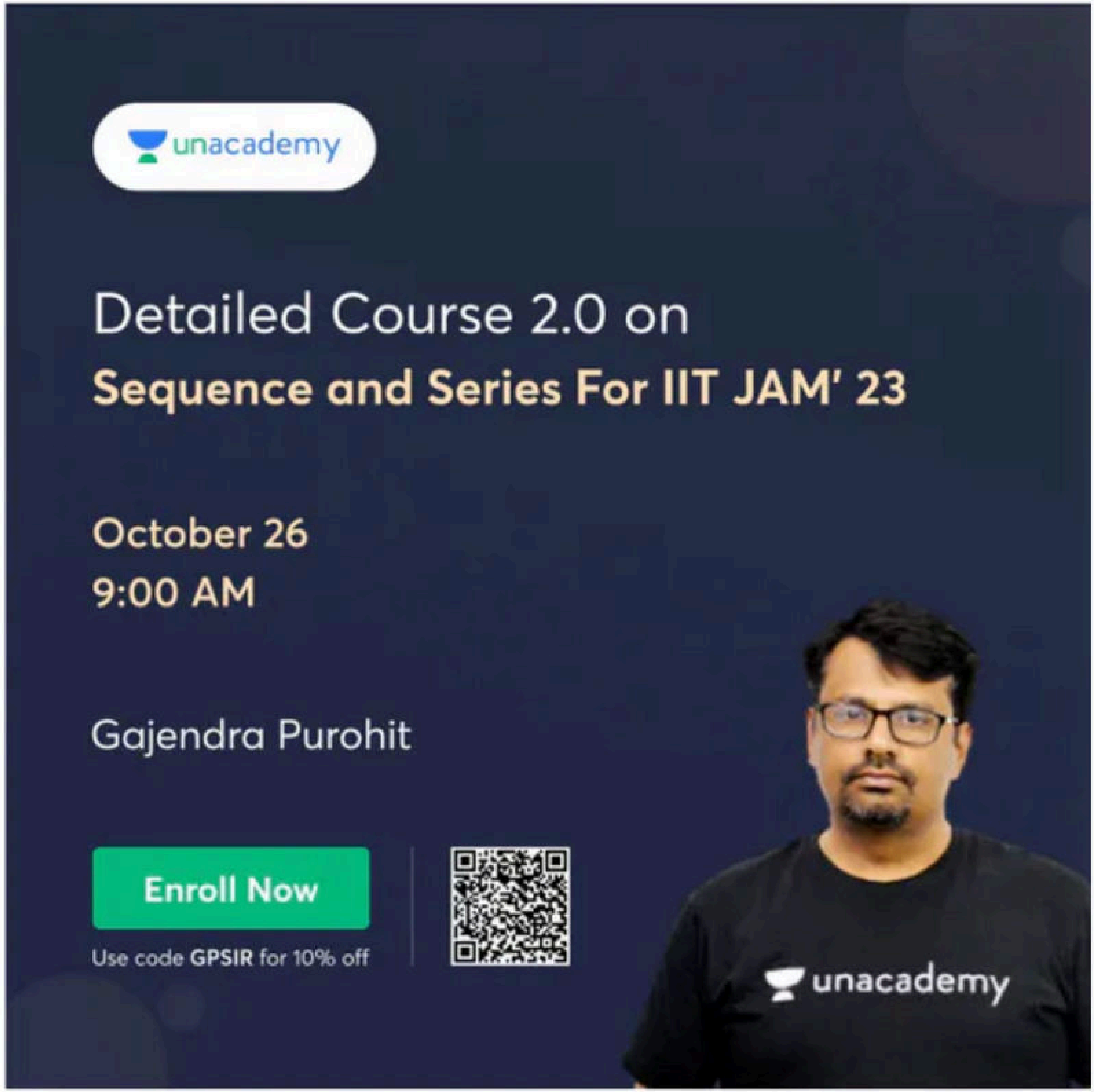
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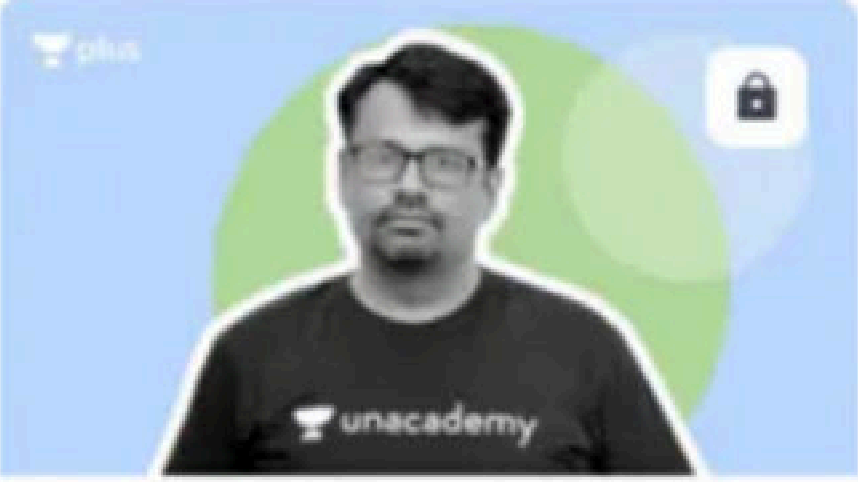

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- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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