

ADHIKAANSH ACADEMY (IITJEE NEET IX X XI XII)

RUN BY:

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MATHS NOTES (CLASS 12TH)



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Key Notes

Chapter-6

Application of Derivatives

- If a quantity y varies with another quantity x , satisfying some rule $y = f(x)$, then $\frac{dy}{dx}$ (or $f'(x)$) represents the rate of change of y with respect to x and $\left. \frac{dy}{dx} \right|_{x=x_0}$ (or $f'(x_0)$) represents the rate of change of y with respect to x at $x = x_0$.
- If two variables x and y are varying with respect to another variable t , i.e., if $x = f(t)$ and $y = g(t)$ then by Chain Rule
- $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$, if $\frac{dx}{dt} \neq 0$
 - (a) A function f is said to be increasing on an interval (a, b) if $x_1 < x_2$ in $(a, b) \Rightarrow f(x_1) \leq f(x_2)$ for all $x_1, x_2 \in (a, b)$.
Alternatively, if $f'(x) \geq 0$ for each x in (a, b)
 - (b) decreasing on (a, b) if $x_1 < x_2$ in $(a, b) \Rightarrow f(x_1) \geq f(x_2)$ for all $x_1, x_2 \in (a, b)$.
Alternatively, if $f'(x) \leq 0$ for each x in (a, b)
- The equation of the tangent at (x_0, y_0) to the curve $y = f(x)$ is given by
- $y - y_0 = \left. \frac{dy}{dx} \right|_{(x_0, y_0)} (x - x_0)$
- If $\frac{dy}{dx}$ does not exist at the point (x_0, y_0) , then the tangent at this point is parallel to the y -axis and its equation is $x = x_0$.

Key Notes

- If tangent to a curve $y = f(x)$ at $x = x_0$ is parallel to x-axis, then $\left. \frac{dy}{dx} \right|_{x=x_0}$

- Equation of the normal to the curve $y = f(x)$ at a point (x_0, y_0) is given by

$$y - y_0 = \frac{-1}{\left. \frac{dy}{dx} \right|_{(x_0, y_0)}} (x - x_0)$$

- If $\left. \frac{dy}{dx} \right|_{(x_0, y_0)}$ is zero, then equation of the normal is $x = x_0$.
- If $\left. \frac{dy}{dx} \right|_{(x_0, y_0)}$ does not exist, then the normal is parallel to x-axis and its equation is $y = y_0$.
- Let $y = f(x)$, Δx be a small increment in x and Δy be the increment in y corresponding to the increment in x , i.e., $\Delta y = f(x + \Delta x) - f(x)$. Then dy given by $dy = f'(x) dx$ or $dy = \left(\frac{dy}{dx} \right) \Delta x$ is a good approximation of Δy when $dx = \Delta x$ is relatively small and we denote it by $dy \approx \Delta y$.
- A point c in the domain of a function f at which either $f'(c) = 0$ or f is not differentiable is called a critical point of f .
- **First Derivative Test** Let f be a function defined on an open interval I . Let f be continuous at a critical point c in I . Then,
 - If $f'(x)$ changes sign from positive to negative as x increases through c , i.e., if $f'(x) > 0$ at every point sufficiently close to and to the left of c , and $f'(x) < 0$ at every point sufficiently close to and to the right of c , then c is a point of local maxima.
 - If $f'(x)$ changes sign from negative to positive as x increases through c , i.e., if $f'(x) < 0$ at every point sufficiently close to and to the left of c , and $f'(x) > 0$ at every point sufficiently close to and to the right of c , then c is a point of local minima.
 - If $f'(x)$ does not change sign as x increases through c , then c is neither a point of local maxima nor a point of local minima. In fact, such a point is called point of inflexion.

Key Notes

- **Second Derivative Test** Let f be a function defined on an interval I and $c \in I$. Let f be twice differentiable at c . Then, $x = c$ is a point of local maxima if $f'(c) = 0$ and $f''(c) < 0$

The values $f(c)$ is local maximum value of f .

- (i) $x = c$ is a point of local minima if $f'(c) = 0$ and $f''(c) > 0$

In this case, $f(c)$ is local minimum value of f .

- (ii) The test fails if $f'(c) = 0$ and $f''(c) = 0$.

In this case, we go back to the first derivative test and find whether c is a point of maxima, minima or a point of inflexion.

- Working rule for finding absolute maxima and/or absolute minima

Step 1: Find all critical points of f in the interval, i.e., find points x where either $f'(x) = 0$ or f is not differentiable.

Step 2: Take the end points of the interval.

Step 3: At all these points (listed in Step 1 and 2), calculate the values of f .

Step 4: Identify the maximum and minimum values of f out of the values calculated in Step

- This maximum value will be the absolute maximum value of f and the minimum value will be the absolute minimum value of f .

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