

DIFFERENTIAL CALCULUS

1) Evaluate : $\lim_{x \rightarrow 4} \frac{(x-4)}{(x^2-x-12)}$

Solution:

$$\lim_{x \rightarrow 4} \frac{(x-4)}{(x^2-x-12)} = \frac{4-4}{4^2-4-12} = \frac{0}{0}, \text{ indeterminate}$$

L'Hospital's rule:

$$\lim_{x \rightarrow 4} = \frac{1}{2x-1} \quad x=4$$

$$= \frac{1}{2(4)-1}$$

$$= \frac{1}{7}$$

2) Evaluate : $\lim_{x \rightarrow 4} (x^2 + 3x - 4)$

Solution:

$$\lim_{x \rightarrow 4} (x^2 + 3x - 4)$$

$$x=4$$

$$= (4)^2 + 3(4) - 4$$

$$= 24$$

3) Evaluate : $\lim_{x \rightarrow 1} (2-x) \tan \frac{\pi x}{2}$

Solution:

$$= (2-1) \tan \frac{\pi(1)}{2} = 1^{\infty}, \text{ indeterminate}$$

$$\ln \text{ limit} = \tan \frac{\pi x}{2} \ln(2-x) = \frac{\ln(2-x)}{\frac{1}{\tan \frac{\pi x}{2}}} = \frac{\ln(2-x)}{\cot \frac{\pi x}{2}}$$

> $d \ln u = \frac{du}{u}$ and $d \tan u = \sec^2 u du$
L'Hospital's rule:

$$\ln \text{ limit} = \frac{\frac{-1}{2-x}}{\sec^2 \frac{\pi}{2} \left(\frac{\pi}{2} \right)} = \frac{\frac{-1}{2-1}}{-\sec^2 \frac{\pi(1)}{2} \left(\frac{\pi}{2} \right)} = \frac{-1}{-\frac{\pi}{2}} = \frac{2}{\pi}$$

$$\ln \text{ limit} = \frac{2}{\pi}$$

$$e^{\ln \text{ limit}} = e^{2/\pi}$$

$$\text{Limit} = e^{2/\pi}$$

4) Differentiate the equation: $y = \frac{x^2}{x+1}$

Solution:

$$y = \frac{x^2}{x+1}$$

$$d\left(\frac{u}{v}\right) = \frac{vdu - u dv}{v^2}$$

$$u = x^2; du = 2x$$

$$v = x+1; v^2 = (x+1)^2; dv = 1$$

$$y' = \frac{(x+1)(2x) - x^2(1)}{(x+1)^2}$$

$$= \frac{2x^2 + 2x - x^2}{(x+1)^2}$$

$$y' = \frac{x^2 + 2x}{(x+1)^2}$$

5) Find the slope of $x^2 y = 8$ at the point (2, 2).

Solution:

$$x^2 y = 8$$

$$y = \frac{8}{x^2}$$

$$\text{slope} = y'$$

$$y' = \frac{-2x(8)}{x^4} = \frac{-16}{x^3}$$

$$x=2$$

$$y' = \frac{-16}{2^3} = \frac{-16}{8}$$

$$y' = -2$$

6) Find the coordinates of the vertex of the parabola $y = x^2 - 4x + 1$ by making use of the fact that at the vertex, the slope of the tangent is zero.

Solution:

$$y = x^2 - 4x + 1$$

$$\text{slope} = y'$$

$$y' = 2x - 4$$

$$y' = 0$$

$$0 = 2x - 4$$

$$x = 2$$

$$y = (2)^2 - 4(2) + 1$$

$$y = -3$$

$$\text{The vertex is at } (2, -3)$$

Differential Calculus Problems With Solution

John Hind



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