SCIENTIFIC OFFICER: PHYSICS

CALCULUS

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Limits of Trignometric Functions

$$\lim_{x \to 0} \sin x = 0$$

$$\lim_{x \to 0} \cos x = 1$$

$$\lim_{x \to 0} \frac{\sin x}{x} = 1$$

$$\lim_{x \to 0} \frac{\tan x}{x} = 1$$

$$\lim_{x \to 0} \frac{1 - \cos x}{x} = 0$$

$$\lim_{x \to 0} \frac{\sin^{-1} x}{x} = 1$$

$$\lim_{x \to 0} \frac{\tan^{-1} x}{x} = 1$$

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Limits of Log & Exponential Fns.

$$\lim_{x \to 0} e^x = 1$$

$$\lim_{x \to 0} \frac{e^x - 1}{x} = 1$$

$$\lim_{x \to 0} \frac{a^x - 1}{x} = \log_e a$$

$$\lim_{x \to 0} \frac{\log(1 + x)}{x} = 1$$

$$\lim_{x \to \infty} \left(1 + \frac{1}{x}\right)^x = e$$

$$\lim_{x \to 0} (1 + x)^{\frac{1}{x}} = e$$

$$\lim_{x \to \infty} \left(1 + \frac{a}{x}\right)^x = e^a$$

Limits of the form 1^∞

$$\lim_{x \to 0} (1 + x)^{\frac{1}{x}} = e$$

$$\lim_{x \to \infty} \left(1 + \frac{1}{x}\right)^{x} = e$$

$$\lim_{x \to \infty} \left(1 + \frac{a}{x}\right)^{x} = e^{a}$$

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Limits of the form x^n

$$\lim_{x \to a} \frac{(x^n - a^n)}{x - a} = n(a)^{n-1}$$

Existence of limit

- To check if limit exist for $f(x)$ at $x = a$

$$\text{i.e.} \lim_{x\to a^-} f(x) = \lim_{x\to a^+} f(x) = f(a)$$

- Differentiability $f'(x) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h}$

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L-Hospital's Rule

If $\lim_{x \to a} \frac{f(x)}{g(x)}$ gives $\frac{0}{0}$ form

where

$f(a) = 0$

$g(a) = 0$

$$\lim_{x \to a} \frac{f(x)}{g(x)} = \frac{f'(a)}{g'(a)}$$

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Basic Derivatives

$$\frac{dk}{dx} = 0$$ where k = constant

$$\frac{d(x)}{dx} = 1$$

$$\frac{d(kx)}{dx} = k$$

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

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Differential of Log & Exponential Fns.

$$\frac{d(e^x)}{dx} = e^x$$

$$\frac{d(\ln(x))}{dx} = \frac{1}{x}$$

$$\frac{d(a^x)}{dx} = a^x \log a$$

$$\frac{d(x^x)}{dx} = x^x(1 + \ln x)$$

$$\frac{d(\log_a x)}{dx} = \frac{1}{x} \times \frac{1}{\ln a}$$

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Differential of Trigonometric Fns.

$$\frac{d(\sin x)}{dx} = \cos x$$

$$\frac{d(\cos x)}{dx} = -\sin x$$

$$\frac{d(\tan x)}{dx} = \sec^2 x$$

$$\frac{d(\cot x)}{dx} = -\operatorname{cosec}^2 x$$

$$\frac{d(\sec x)}{dx} = \sec x \tan x$$

$$\frac{d(\operatorname{cosec} x)}{dx} = -\operatorname{cosec} x \cot x$$

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Differential Rules

Product Rule $\frac{d}{dx}(f(x)\,g(x)) = f'(x)\,g(x) + f(x)\,g'(x)$

Quotient Rule $\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{f'(x)\,g(x) - f(x)\,g'(x)}{(g\,(x))^2}$

Chain Rule $\frac{d(f(g(x)))}{dx} = f'(g(x))\,g'(x)$

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Hyperbolic Functions.

$\sinh(x) = \frac{e^x - e^{-x}}{2}$	$\operatorname{csch}(x) = \frac{1}{\sinh(x)} = \frac{2}{e^x - e^{-x}}, x \neq 0$
$\cosh(x) = \frac{e^x + e^{-x}}{2}$	$\operatorname{sech}(x) = \frac{1}{\cosh(x)} = \frac{2}{e^x + e^{-x}}$
$\tanh(x) = \frac{\sinh(\mathrm{x})}{\cosh(x)} = \frac{e^x - e^{-x}}{e^x + e^{-x}}$	$\coth(x) = \frac{1}{\tanh(x)} = \frac{e^x + e^{-x}}{e^x - e^{-x}}, x \neq 0$

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Differential of Hyperbolic Fns.

$$\frac{d}{dx}\sinh(x) = \cosh(\mathrm{x})$$

$$\frac{d}{dx}\cosh(x) = \sinh(\mathrm{x})$$

$$\frac{d}{dx}\tanh(x) = \operatorname{sech}^2(x)$$

$$\frac{d}{dx}\coth(x) = -\operatorname{csch}^2(x)$$

$$\frac{d}{dx}\operatorname{sech}(x) = -\tanh(\mathrm{x})\operatorname{sech}(x)$$

$$\frac{d}{dx}\operatorname{csch}(x) = -\coth(x)\operatorname{csch}(x)$$

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$$\lim_{x \to 0} \frac{\sin x^{\circ}}{x}$$

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- $\lim_{x \to 0} \frac{logx}{cotx}$

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- $\lim_{x \to \frac{\pi}{2}} (1 - sinx)tanx$

- $\lim_{x \to 0} x^x$

- $$\lim_{x \to 0} [3\cos x + 2\sin 3x]^{\frac{1}{x}}$$

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- Find the maximum&minimum value of the function $f(x) = 2x^3 - 24x + 107$ in [1,3]

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THANK YOU