Methods Of Differentiation [MOD]

① **Differentiation using first principle:** $f'(x) = \lim_{h \to 0} \frac{f(x+h)-f(x)}{h}$.

② **Derivative of some functions.**

$f(x)$	$f'(x)$
$Sin(x)$	$Cos(x)$
$Cos(x)$	$-Sin(x)$
$Tan(x)$	$Sec^2(x)$
$Cot(x)$	$-Cosec^2(x)$
$Sec(x)$	$Sec(x)Tan(x)$
$Cosec(x)$	$-Cosec(x)Cot(x)$
$arcsin(x)$	$\frac{1}{\sqrt{1-x^2}}$
$arccos(x)$	$\frac{-1}{\sqrt{1-x^2}}$
$arctan(x)$	$\frac{1}{1+x^2}$
$arccot(x)$	$\frac{-1}{1+x^2}$
$arcsec(x)$	$\frac{1}{\lvert x\rvert\sqrt{x^2-1}}$
$arccosec(x)$	$\frac{-1}{\lvert x\rvert\sqrt{x^2-1}}$

$f(x)$	$f'(x)$
x^n	$nx^{(n-1)}$
a^x	$a^x.ln(a)$
e^x	e^x
$ln(x)$	$1/x$
$\log_a(x)$	$1/x\,.\,ln(a)$
$ln(sin(x))$	$cot(x)$
$ln(cos(x))$	$-tan(x)$
$ln(sec(x) + tan(x))$	$sec(x)$

③ **Theorems**

1) $(f(x) \pm g(x))' = f'(x) \pm g'(x)$
2) $(f(x)g(x))' = f'(x)g(x) + f(x)g'(x)$
3) $\left(\frac{f(x)}{g(x)}\right)' = \frac{f'(x)g(x)+f(x)g'(x)}{g^2(x)}$
4) $(f(g(x)))' = f'(g(x))\, x\, g'(x)$

④ Logarithmic Differentiation

1) If a function is product & quotient of many functions
2) If a function is in form: $f(x)^{g(x)}$

⑤ Parametric Differentiation

$$y = f(t) \quad x = g(t)$$

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{f'(t)}{g'(t)}$$

⑥ Differentiation of an Implicit Function

Differentiate directly with respect of required variable.

⑦ Differentiation of an inverse function

If g(x) is inverse of f(x) then, $g'(x) = \frac{1}{f'(g(x))}$

⑧ Differentiation using substitution

(i) $\sqrt{a^2 - x^2} \Rightarrow x = a\sin\theta$ or $a\cos\theta$

(ii) $\sqrt{x^2 + a^2} \Rightarrow x = a\tan\theta$ or $a\cot\theta$

(iii) $\sqrt{x^2 - a^2} \Rightarrow x = a\sec\theta$ or $a\,\mathrm{cosec}\,\theta$

(iv) $\sqrt{\frac{a+x}{a-x}} \Rightarrow x = a\cos\theta$ or $a\cos 2\theta$

(v) $\frac{a+x}{a-x} \Rightarrow x = a\tan\theta$ or $a\cot\theta$

(vi) $\sqrt{\frac{x-\alpha}{\beta-x}}$ or $\sqrt{(x-\alpha)(\beta-x)} \Rightarrow x = \alpha\cos^2\theta + \beta\sin^2\theta$

(vii) $\sqrt{\frac{x-\alpha}{x-\beta}}$ or $\sqrt{(x-\alpha)(x-\beta)} \Rightarrow x = \alpha\sec^2\theta - \beta\tan^2\theta$

⑨ HOD in Parametric form

$$\frac{d^2x}{dy^2} = -\frac{y''}{(y')^3}$$