CHEAT SHEET

Differentiation

Key Formulae

FB formula booklet

Standard Derivatives

$f(x)$	$f'(x)$
x^n	nx^{n-1}
e^x	e^x
a^x	$a^x \ln a$
$\ln x$	$\frac{1}{x}$
$\sin x$	$\cos x$
$\cos x$	$-\sin x$
$\tan x$	$\sec^2 x$ FB

$f(x)$	$f'(x)$
$\sec x$	$\sec x \tan x$ FB
$\operatorname{cosec} x$	$-\operatorname{cosec} x \cot x$ FB
$\cot x$	$-\operatorname{cosec}^2 x$ FB
$\arccos x$	$-\frac{1}{\sqrt{1-x^2}}$
$\arcsin x$	$\frac{1}{\sqrt{1-x^2}}$
$\arctan x$	$\frac{1}{1+x^2}$

Differentiation Rules

- Chain rule

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$

- Product rule

$$\frac{d(uv)}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$$

- Quotient rule FB

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

First Principles

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

$\frac{dx}{dy}$

- $\frac{dx}{dy} = \frac{1}{\frac{dy}{dx}}$

Key Concepts

Stationary Points

- $f'(x) = 0 \Rightarrow (x, f(x))$ is a stationary point
- $f''(x) > 0 \Rightarrow (x, f(x))$ is a minimum point
- $f''(x) < 0 \Rightarrow (x, f(x))$ is a maximum point
- $f''(x) = 0$ AND $f'(x-h)$ & $f'(x+h)$ have the same sign for small $h > 0$. $\Rightarrow (x, f(x))$ is an inflection point

Behaviour of the Curve

- $f'(x) > 0 \Rightarrow$ increasing function
- $f'(x) < 0 \Rightarrow$ decreasing function
- $f''(x) > 0 \Rightarrow$ convex function (increasing gradient)
- $f''(x) < 0 \Rightarrow$ concave function (decreasing gradient)
- Inflection Points: the point at which a curve transitions from convex to concave or vice versa. An inflection point may be a stationary point, but not necessarily.

Implicit Differentiation

- If y is a function of x, then

$$\frac{d}{dx} f(y) = f'(y) \frac{dy}{dx}$$