HANDOUTS | MATERIAL

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* $f(x_1) < f(x_2) \rightarrow$ f is increasing.
* $f(x_1) > f(x_2) \rightarrow$ f is decreasing.
* $f(x_1) = f(x_2) \rightarrow$ f is constant.
* $f'(x) > 0 \rightarrow$ f is increasing.
* $f'(x) < 0 \rightarrow$ f is decreasing.
* $f'(x) = 0 \rightarrow$ f is constant.
* $f''(x) > 0 \rightarrow$ f is concave up.
* $f''(x) < 0 \rightarrow$ f is concave down.
* $f(x_0) \geq f(x) \rightarrow$ f is relative maximum.
* $f(x_0) \leq f(x) \rightarrow$ f is relative minimum.
* $f''(x_0) > 0 \rightarrow$ relative minimum
* $f''(x_0) < 0 \rightarrow$ relative maximum.
* $x = x_0 \rightarrow$ vertical asymptotes.
* $y = y_0 \rightarrow$ horizontal asymptotes.

* $f(x_0) \geq f(x) \longrightarrow$ absolute maximum.
* $f(x_0) \leq f(x) \longrightarrow$ absolute minimum.

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} \quad \text{(Newton's Method)}$$

Mean Value Theorem $= f'(c) = \dfrac{f(b)-f(a)}{b-a}$.

Area function $= A(x) = \frac{1}{3}x^3$

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

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

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

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

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

$\int \cos x \, dx = \sin x + C$

$\int \sec^2 x \, dx = \tan x + C$

$\int \tan x \cdot \sec x \, dx = \sec x + C$

$\int \operatorname{cosec}^2 x \, dx = -\cot x + C$

$\int \operatorname{cosec} \cdot \cot x = -\operatorname{cosec} x + C$

$\sin 2x = \cancel{2\cos 2x}$
$= 2\sin x \cos x$

Σ

* $\sum_{k=1}^{n} k = \frac{n(n+1)}{2}$

* $\sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}$

* $\sum_{k=1}^{n} k^3 = \left(\frac{n(n+1)}{2}\right)^2$

* $A = \text{area}(R) = \lim_{n \to +\infty} [\text{area}(R_n)]$

* $\Delta x = \frac{b-a}{n}$

* $A = \lim_{n \to +\infty} \sum_{k=1}^{n} f(x_k^*)\Delta x$ (App area)

* Left end point $= x_k^* = a + (k-1)\Delta x$
* Right end point $= x_k^* = a + k\Delta x$
* Mid point $= x_k^* = a + (k - \frac{1}{2})\Delta x$
* Area of trapezoid $= A = \frac{1}{2} h(b_1 + b_2)$
* Area of k^{th} Rectangle $= f(x_k^*)\Delta x$

* Reimann Sum $= \lim_{\max \Delta x_k \to 0} \sum_{k=1}^{n} f(x_k^*)\Delta x_k$

* First fundamental theorem of calculus:

$$\int_a^b f(x)\,dx = F(b) - F(a)$$

* Integral Mean Value theorem:

$$\int_a^b f(x)\,dx = f(x_k^*)(b-a).$$

* $f_{avg} = \frac{1}{b-a} \int_a^b f(x)\,dx.$

* $V = A \cdot h.$

* volume of slice $= V_k \approx A(x_k^*)\Delta x_k.$

* Area of cross section :

$$A(x) = \pi [f(x)]^2$$

* Volume of solid: $V = \int_a^b \pi [f(x)]^2 dx$

* Volume of sphere: $\frac{4}{3} \pi r^3$

$$V = \int_a^b \pi [(f(x))^2 - (g(x))^2]$$

* Volume of cylindrical shell:

$$V = 2\pi (\text{average radius})(\text{hight})(\text{thickness}).$$

* Volume of cylindrical shell:

$$V = \int_a^b 2\pi x f(x)\, dx$$

* Surface area of cylinder : $2\pi x f(x)$

* $L_k = \sqrt{1 + (f'(x_k^*))^2}\, \Delta x_k$.

* $L = \int_a^b \sqrt{1+(f'(x))^2}\, dx$ (Arc length).

* Surface area of frustum = $S = \pi(r_1 + r_2) l$.

* Surface area = $S = \int_a^b 2\pi f(x) \sqrt{1 + (f'(x))^2}\, dx$

* Area of rectangle = $w(x_k^*)\Delta x_k$.

* Fluid force/fluid pressure =

$$F = \int_a^b \rho h(x) w(x)\, dx$$

* limits exist $\longrightarrow$ Improper integral converges.

limits not exist $\longrightarrow$ Improper integral diverges.

* Spring Constant $= F = kx$.

Sequence:

Answer = well defined number (1, 2, 3...) then sequence converges.

Answer = Infinity or negative ifinity then sequence diverges.

Recursion formula: $a_{n+1} = \frac{1}{2}\left(a_n + \frac{3}{a_n}\right)$

Sequence Ratio Test:

$a_{n+1}/a_n > 1 \longrightarrow$ Increasing

$a_{n+1}/a_n < 1 \longrightarrow$ decreasing

$a_{n+1}/a_n \geq 1 \longrightarrow$ Non-decreasing

$a_{n+1}/a_n \leq 1 \longrightarrow$ Non-increasing

Sequence derivative Test:

$f'(x) > 0 \longrightarrow$ Increasing

$f'(x) < 0 \longrightarrow$ Decreasing

$f'(x) \geq 0 \longrightarrow$ Non-decreasing

$f'(x) \leq 0 \longrightarrow$ Non-increasing

Geometric Series :

$$a + ar + ar^2 + \cdots + ar^{k-1} + \cdots$$

In geometric series each term is obtained by multiplying previous term.

In G.M Series if :

$|r| < 1 \longrightarrow$ converges

$|r| \geq 1 \longrightarrow$ Diverges

Sum of G.M Series :

$$\frac{a}{1-r} = a + ar + ar^2 + \cdots + ar^{k-1} + \cdots$$

Harmonic Series :

$$\sum_{k=1}^{\infty} \frac{1}{k} = 1 + \frac{1}{2} + \frac{1}{3} + \cdots$$

Harmonic series always diverges.

H·M Series Divergence Test:

$\lim_{k\to\infty} U_k \neq 0 \longrightarrow$ Diverges

$\lim_{k\to\infty} U_k = 0 \longrightarrow$ Either converge or diverge.

P / Hyper Harmonic Series:

$$\sum_{k=1}^{\infty} \frac{1}{k^p} = 1 + \frac{1}{2^p} + \frac{1}{3^p} + \cdots$$

$p > 1 \longrightarrow$ Converges

$0 < p \leq 1 \longrightarrow$ Diverges.

Ratio Test :

$$P = \lim_{k \to \infty} \frac{U_{k+1}}{U_k}$$

* $P < 1$ ⟶ series converges.
* $P > 1$ ⟶ series diverges.
* $P = 1$ ⟶ Either converges / Diverges
* $P = \infty$ ⟶ series diverges.

Limit Comparison Test :

$$P = \lim_{k \to \infty} \frac{a_k}{b_k}$$

* $P =$ finite and $P > 0$ ⟶ series both converge or both diverge.

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