

Calculus Formulas

Power Rules: $\frac{d}{dx} x^n = nx^{n-1}$ and $\int x^n dx = \frac{x^{n+1}}{n+1} + c$		Product Rule: $\frac{d}{dx} [f(x) \cdot g(x)] = f(x) \cdot g'(x) + f'(x) \cdot g(x)$	
Quotient Rule: $\frac{d}{dx} \left[\frac{f(x)}{g(x)} \right] = \frac{g(x) \cdot f'(x) - f(x) \cdot g'(x)}{[g(x)]^2}$		Reciprocal Rule: $\frac{d}{dx} \left[\frac{1}{g(x)} \right] = \frac{-g'(x)}{[g(x)]^2}$	
Chain Rule: $\frac{d}{dx} (f \circ g)(x) = f'[g(x)] \cdot g'(x)$		Integration-by-Parts: $\int u \, dv = uv - \int v \, du$	
Trigonometric Functions		Inverse Trigonometric Functions	
Derivative	Integral	Derivative	Integral
$\frac{d}{dx} \sin x = \cos x$	$\int \sin x \, dx = -\cos x + c$	$\frac{d}{dx} \sin^{-1} x = \frac{1}{\sqrt{1-x^2}}$	$\int \frac{1}{\sqrt{a^2-u^2}} \, dx = \sin^{-1} \frac{u}{a} + c$
$\frac{d}{dx} \cos x = -\sin x$	$\int \cos x \, dx = \sin x + c$	$\frac{d}{dx} \cos^{-1} x = \frac{-1}{\sqrt{1-x^2}}$	
$\frac{d}{dx} \tan x = \sec^2 x$	$\int \tan x \, dx = \ln \sec x + c$ $\int \sec^2 x \, dx = \tan x + c$	$\frac{d}{dx} \tan^{-1} x = \frac{1}{1+x^2}$	$\int \frac{1}{a^2+u^2} \, dx = \frac{1}{a} \tan^{-1} \frac{u}{a} + c$
$\frac{d}{dx} \cot x = -\csc^2 x$	$\int \cot x \, dx = \ln \sin x + c$ $\int \csc^2 x \, dx = -\cot x + c$	$\frac{d}{dx} \cot^{-1} x = \frac{-1}{1+x^2}$	
$\frac{d}{dx} \sec x = \sec x \cdot \tan x$	$\int \sec x \, dx = \ln \sec x + \tan x + c$ $\int \sec x \cdot \tan x \, dx = \sec x + c$	$\frac{d}{dx} \sec^{-1} x = \frac{1}{ x \sqrt{x^2-1}}$	$\int \frac{1}{u\sqrt{u^2-a^2}} \, dx = \frac{1}{a} \sec^{-1} \frac{u}{a} + c$
$\frac{d}{dx} \csc x = -\csc x \cdot \cot x$	$\int \csc x \, dx = \ln \csc x - \cot x + c$ $\int \csc x \cdot \cot x \, dx = -\csc x + c$	$\frac{d}{dx} \csc^{-1} x = \frac{-1}{ x \sqrt{x^2-1}}$	
Identities: $\begin{cases} \sin^2 x + \cos^2 x = 1 & \sin 2x = 2 \sin x \cos x & \cos^2 x = \frac{1 + \cos 2x}{2} \\ 1 + \cot^2 x = \csc^2 x & \cos 2x = \cos^2 x - \sin^2 x & \sin^2 x = \frac{1 - \cos 2x}{2} \\ \tan^2 x + 1 = \sec^2 x & \cos(x+y) = \cos x \cos y - \sin x \sin y & \sin(x+y) = \sin x \cos y + \cos x \sin y \end{cases}$			
Exponential Functions		Logarithmic Functions	
Derivative	Integral	Derivative	Integral
$\frac{d}{dx} (e^x) = e^x$	$\int e^x \, dx = e^x + c$	$\frac{d}{dx} (\ln x) = \frac{1}{x}$	$\int \frac{1}{x} \, dx = \ln x + c$
$\frac{d}{dx} (b^x) = (\ln b)b^x$	$\int b^x \, dx = \frac{b^x}{\ln b} + c$	$\frac{d}{dx} (\log_b x) = \frac{1}{(\ln b)x}$	
Definition of Log base b: $\log_b N = x \Leftrightarrow b^x = N$		Change of Base Formula: $\log_b x = \frac{\ln x}{\ln b} = \frac{\log x}{\log b}$	
Identities: $\begin{cases} \ln(e^x) = x & e^{\ln x} = x & \ln e = \log_{10} e = \log_b b = 1 \\ \log_b(b^x) = x & b^{\log_b x} = x & \ln 1 = \log 1 = \log_b 1 = 0 \end{cases}$			

Infinite Series: Definitions & Tests

1. Series:
$$\begin{cases} \sum_{n=1}^{\infty} a_n = a_1 + a_2 + a_3 + \dots \text{ (Infinite Series)} \\ s_n = \sum_{i=1}^n a_i = a_1 + a_2 + \dots + a_n \text{ (nth Partial Sum)} \\ \text{if } \lim_{n \rightarrow \infty} s_n = s \text{ where } s \in \mathbb{R} \text{ then } \sum_{n=1}^{\infty} a_n = s \text{ (Infinite Sum)} \end{cases}$$
2. Geometric Series:
$$\sum_{n=0}^{\infty} ar^n = a + ar + ar^2 + ar^3 + \dots = \begin{cases} \frac{a}{1-r}, \text{ if } |r| < 1 \\ \text{diverges, if } |r| \geq 1 \end{cases}$$
3. P-Series:
$$\sum_{n=1}^{\infty} \frac{1}{n^p} \Rightarrow \begin{cases} \text{converges, if } p > 1 \\ \text{diverges, if } p \leq 1 \end{cases} \text{ if } p = 1, \text{ the series is called the harmonic series.}$$
4. Quick Divergence Test: Given $\sum_{n=1}^{\infty} a_n \Rightarrow \begin{cases} \text{if } \lim_{n \rightarrow \infty} a_n \neq 0, \text{ then } \sum_{n=1}^{\infty} a_n \text{ diverges} \\ \text{if } \lim_{n \rightarrow \infty} a_n = 0, \text{ then No Conclusion! Do another test!} \end{cases}$
5. Integral Test: Given $\sum_{n=c}^{\infty} a_n, a_n > 0, a_n \text{ decreasing} \Rightarrow \begin{cases} \text{if } \int_c^{\infty} a_n \, dn \text{ converges then } \sum_{n=c}^{\infty} a_n \text{ converges} \\ \text{if } \int_c^{\infty} a_n \, dn \text{ diverges then } \sum_{n=c}^{\infty} a_n \text{ diverges} \end{cases}$
6. Ratio Test: Given $\sum_{n=c}^{\infty} a_n, a_n > 0 \Rightarrow \text{if } \lim_{n \rightarrow \infty} \frac{a_{n+1}}{a_n} = p \text{ then } \begin{cases} \sum_{n=c}^{\infty} a_n \text{ converges, when } p < 1, \\ \sum_{n=c}^{\infty} a_n \text{ diverges, when } p > 1, \\ \text{No Conclusion, when } p = 1 \end{cases}$
7. Root Test: Given $\sum_{n=c}^{\infty} a_n, a_n > 0 \Rightarrow \text{if } \lim_{n \rightarrow \infty} \sqrt[n]{a_n} = \lim_{n \rightarrow \infty} (a_n)^{\frac{1}{n}} = p \text{ then } \begin{cases} \sum_{n=c}^{\infty} a_n \text{ converges, when } p < 1, \\ \sum_{n=c}^{\infty} a_n \text{ diverges, when } p > 1, \\ \text{No Conclusion, when } p = 1 \end{cases}$
8. Limit Comparison Test: $\sum_{n=c}^{\infty} a_n \text{ and } \sum_{n=c}^{\infty} b_n, a_n > 0, b_n > 0 \Rightarrow \begin{cases} \text{if } \lim_{n \rightarrow \infty} \frac{a_n}{b_n} = p, p > 0, p \text{ finite} \\ \text{then both series converge or both diverge} \end{cases}$
9. Comparison Test: $\sum_{n=c}^{\infty} a_n \text{ and } \sum_{n=c}^{\infty} b_n, a_n \geq 0, b_n \geq 0, a_n \leq b_n \Rightarrow \begin{cases} \text{if } b_n \text{ converges then } a_n \text{ converges,} \\ \text{if } a_n \text{ diverges then } b_n \text{ diverges} \end{cases}$
10. Alternating Series Test: Given $\sum_{n=c}^{\infty} (-1)^n a_n, \text{ if } a_n > 0, a_{n+1} < a_n, \lim_{n \rightarrow \infty} a_n = 0, \text{ then } \sum_{n=c}^{\infty} (-1)^n a_n \text{ converges}$