Calc II Notes

SuperExago and Tepoys August 31, 2024

Abstract

This will primarily consist of formulas necessary for calculations

1 Derivatives

Instantaneous rate of change at a point

1.1 Limit Definition of Derivatives

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

1.2 Basic Derivatives

Name	Derivative	Result
Constant	$\frac{d}{dx}[C]$	0
Power	$\frac{d}{dx}[u^n]$	$n*u^{n-1}*u'$
Exponential	$rac{d}{dx}[a^u]$	$a^u * u\prime * ln(a)$
Constant Multiply	$\frac{d}{dx}[C*f(x)]$	$C * \frac{d}{dx}[f(x)]$
Multiply Functions	$\frac{d}{dx}[f(x)g(x)]$	f'(x)g(x) + g'(x)f(x)
Divide Functions	$\frac{d}{dx} \left[\frac{f(x)}{g(x)} \right]$	$\frac{f\prime(x)g(x)-g\prime(x)f(x)}{g(x)^2}$
Chain Rule	$\frac{d}{dx}[f(g(u))]$	$f\prime(g(u))*g\prime(u)*u\prime$
Logarithm	$rac{d}{dx}[log_a u]$	$\frac{u\prime}{uln(a)}$

1.3 Trigonometric Derivatives

Name	Derivative	Result
Sine	$rac{d}{dx}[sin(u)]$	$cos(u)u\prime$
Cosine	$\frac{d}{dx}[cos(u)]$	$-sin(u)u\prime$
Tangent	$\frac{d}{dx}[tan(u)]$	$sec^2(u)u\prime$
Cotangent	$\frac{d}{dx}[cot(u)]$	$-csc^2(u)u\prime$
Secant	$\frac{d}{dx}[sec(u)]$	$sec(u)tan(u)u\prime$
Cosecant	$\frac{d}{dx}[csc(u)]$	-csc(u)cot(u)u

1.4 Inverse Trigonometric Derivatives

For any "co-" version of the trig function multiply the result by -1

Name	Derivative	Result
Inverse Sine	$\frac{d}{dx}[sin^{-1}u]$	$\frac{u\prime}{\sqrt{1-u^2}}$
Inverse Tangent	$\frac{d}{dx}[tan^{-1}u]$	$\frac{u\prime}{1+u^2}$
Inverse Secant	$\frac{d}{dx}[sec^{-1}u]$	$\frac{u\prime}{u\sqrt{u^2-1}}$

1.5 Separable Differential Equation

If $\frac{dy}{dx} = f(y) * g(x)$ than $\frac{1}{f(y)} dy = g(x) dx$ If $\frac{dy}{dt} = ky$ where k is a constant than $|y| = Ce^{kt}$ If f(x) = x + y then $f'(x) = 1 + \frac{dy}{dx}$

2 Integrals

Area under the curve (also known as anti-derivative)

2.1 Basic Integrals

Note that $F\prime(x)=f(x)$

Name	Integral	Result
Fundamental theorem of Calculus	$\int_a^b f(x)$	F(b) - F(a)
Simple Function	$\int f(x)$	F(x) + C
Power Rule	$\int [x^n]dx$	$\frac{x^{n+1}}{n+1} + C$
Reciprocal Function	$\int \left[\frac{1}{x}\right] dx$	ln x + C
Exponential Function	$\int [a^u]dx$	$\frac{a^u}{ln(a)u\prime}$

2.2 Trigometric Integrals

Name	Integral	Result
Sine	$\int [sinx]dx$	-cosx + C
Cosine	$\int [cosx]dx$	sinx + C
Secant	$\int [sec^2x]dx$	tanx + C
Cosecant	$\int [csc^2x]dx$	-cotx + C
Sectan	$\int [secxtanx]dx$	secx + C
Coseccotan	$\int [cscxcotx]dx$	-cscx + C

3 Applications of Integrals

Applying integrals to solve problems

3.1 Volumes of Revolution

Rotating a function(s) around an axis to find the volume of the 3d resulting object

Name	Formula
Total Volume	$\int_a^b A(x)$
Disk Method	$\int_a^b \pi f(x)^2 dx \mathbf{s}$
Shell method	$\int_{a}^{b} 2\pi x f(x) dx$
Shell between	$\int_{a}^{b} 2\pi x (f(x) - g(x)) dx$
Washer method	$\int_a^b \pi(f(x)^2 - g(x)^2) dx$

3.2 Work

 ${\cal F}$ is force, a and b are points along an axis with b being further than a, and W is work

Name	Formula	Notes
Constant Force Work	F(b-a)	Requires Force to be Constant
Varied Force Work	$\int_{a}^{b} F(x)dx$	If direction of force and motion are same than $F(x) >= 0$ else $F(x) <= 0$
Hooke's Law	F(x) = kx	k is the spring constant and x is the spring constant
Pump Liquid	$int_a^b d*h(y)A(y)dy$	d is density, $h(y)$ is distance the layer is being lifted, $A(y)$ is the area of the layer