Subject: Calculus I,II&III
Created by: Ariel Li
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Differentiation and Integration Rules for Calculus I&II

*** Some Suggestions About When & How to Use This Handout**

If you are in **Math 1304 Calculus I** class, you will only need Subsection a. Differentiation/Derivative in Section A-D and Section E;

if you are in **Math 2304 Calculus II** class, you will find Subsection b. Integration/Antiderivative in Section A-D useful;

if you are in **Math 2304 Calculus III c**lass, take this handout as a review of Calculus I & II.

***Because this handout is very concise, it would better help you with specific examples from your textbook and/or class notes during your tutoring sessions.**

A. General Rules (*c* is a constant)

a. Differentiation/Derivative

$\frac{dy}{dx}(c)=0$	$\frac{dy}{dx}(x^n)=nx^{n-1}$	$\frac{dy}{dx}(e^x)=e^x$
$(cf)'=cf'$	$(f+g)'=f'+g'$	$(f-g)'=f'-g'$

The Product Rule: $(fg)'=fg'+f'g$	**The Quotient Rule:** $\left(\frac{f}{g}\right)'=\frac{gf'-gf'}{g^2}$

b. Integration/Antiderivative

$\int x^n\,dx=\frac{x^{n+1}}{n+1}(n\neq -1)$	$\int e^x dx=e^x$
$\int cf(x)dx=c\int f(x)dx$	$\int[f(x)\pm g(x)]dx=\int f(x)dx\pm\int g(x)dx$

B. Derivative & Antiderivative of Trigonometric Functions

a. Differentiation/Derivative

$\frac{dy}{dx}(\sin x)=\cos x$	$\frac{dy}{dx}(\cos x)=-\sin x$	$\frac{dy}{dx}(\tan x)=\sec^2 x$

(510) 885-3674
www.csueastbay.edu/scaa
scaa@csueastbay.edu

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$\frac{dy}{dx}(\csc x) = -\csc x \cot x$	$\frac{dy}{dx}(\sec x) = \sec x \tan x$	$\frac{dy}{dx}(\cot x) = -\csc^2 x$

b. Integration/Antiderivative

$\int \cos x\, dx = \sin x$	$\int \sin x\, d = -\cos x$
$\int \sec^2 x\, dx = \tan x$	$\int \csc x \cot x\ dx = -\csc x$
$\int \sec x \tan x\, dx = \sec x$	$\int \csc^2 x\, dx = -\csc x$
$\int \sec x\, dx = \ln\lvert\sec x + \tan x\rvert$	$\int \csc x\, dx = \ln\lvert\csc x - \cot x\rvert$
$\int \tan x\, dx = \ln\lvert\sec x\rvert$	$\int \cot x\ dx = \ln\lvert\sin x\rvert$

C. Inverse Trigonometric Functions

a. Differentiation/Derivative

$\frac{dy}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{(1-x^2)}}$	$\frac{dy}{dx}(\sec^{-1} x) = \frac{1}{x\sqrt{(x^2-1)}}$	$\frac{dy}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$
$\frac{dy}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{(1-x^2)}}$	$\frac{dy}{dx}(\csc^{-1} x) = \frac{-1}{x\sqrt{(x^2-1)}}$	$\frac{dy}{dx}(\cot^{-1} x) = \frac{-1}{1+x^2}$

b. Integration/Antiderivative

$\int \frac{dx}{x^2+a^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$	$\int \frac{dx}{\sqrt{a^2-x^2}} = \sin^{-1}\left(\frac{x}{a}\right), \quad a > 0$

D. Exponential and Logarithmic Functions

a. Differentiation/Derivative

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$\frac{dy}{dx}(a^x) = a^x \ln a$	$\frac{dy}{dx}(\log_a x) = \frac{1}{x \ln a}$	$\frac{dy}{dx}(\ln x) = \frac{1}{x}$

b. Integration/Antiderivative

$\int \frac{1}{x} dx = \ln\|x\|$	$\int b^x dx = \frac{b^x}{\ln b}$

E. Composition of Functions (The Chain Rule)

The Chain Rule: If g is differentiable at x and f is differentiable at $g(x)$, then the composite function $F = fog$ defined by $F(x) = f(g(x))$ is differentiable at x and F' is given by the product:
$F'(x) = f'(g(x)) * g'(x)$

References: The Following works were referred to during the creation of this handout: *Calculus Early Transcendentals* (5E)