Trig Identities

Basic & Pythagorean

$\sin(x) = \frac{1}{\csc(x)}$ $\quad$ $\csc(x) = \frac{1}{\sin(x)}$

$\cos(x) = \frac{1}{\sec(x)}$ $\quad$ $\sec(x) = \frac{1}{\cos(x)}$

$\tan(x) = \frac{\sin(x)}{\cos(x)} = \frac{1}{\cot(x)}$ $\quad$ $\cot(x) = \frac{\cos(x)}{\sin(x)} = \frac{1}{\tan(x)}$

$\sin^2(x) + \cos^2(x) = 1$ $\quad$ $\tan^2(x) + 1 = \sec^2(x)$

$\cot^2(x) + 1 = \csc^2(x)$ $\quad$ $\sin(-x) = -\sin(x)$

$\cos(-x) = cos(x)$ $\quad$ $\tan(-x) = -\tan(x)$

Angle Sum & Difference

$\sin(\alpha \pm \beta = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\tan(\alpha \pm \beta) = \frac{\tan(\alpha)\pm\tan(\beta)}{1\mp\tan(\alpha)\tan(\beta)}$

Double-Angle

$\sin(2x) = 2\sin(x)\cos(x)$

$\tan(2x) = \frac{2\tan(x)}{1-\tan^2(x)}$

$\cos(2x) = \cos^2(x) - \sin^2(x)$

Half-Angle

$\sin(\frac{\theta}{2}) = \pm\sqrt{\frac{1-\cos(\theta)}{2}}$

$\cos(\frac{\theta}{2}) = \pm\sqrt{\frac{1+\cos(\theta)}{2}}$

$\tan(\frac{\theta}{2}) = \frac{\sin(\theta)}{1+\cos(\theta)} = \frac{1-\cos(\theta)}{\sin(\theta)}$

Power Reduction

$\sin^2(x) = \frac{1}{2}[1 - \cos(2x)]$

$\cos^2(x) = \frac{1}{2}[1 + \cos(2x)]$

$\tan^2(x) = \frac{1-\cos(2x)}{1+\cos(2x)}$

Sum to Product

$\sin(x) + \sin(y) = 2\sin(\frac{x+y}{2})\cos(\frac{x-y}{2})$

$\sin(x) - \sin(y) = 2\cos(\frac{x+y}{2})\sin(\frac{x-y}{2})$

$\cos(x) + \cos(y) = 2\cos(\frac{x+y}{2})\cos(\frac{x-y}{2})$

$\cos(x) - \cos(y) = -2\sin(\frac{x+y}{2})\sin(\frac{x-y}{2})$

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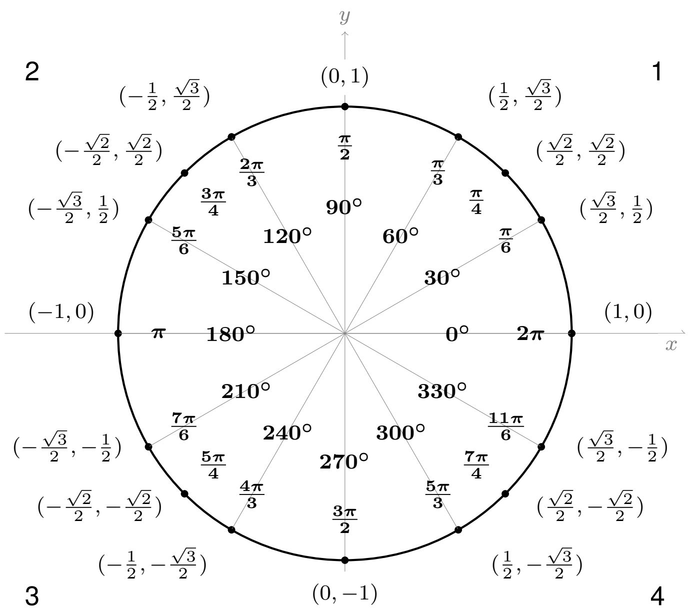
Unit Circle



$(x = \cos\theta, y = \sin\theta)$ $\quad$ $\tan\theta = \dfrac{\sin\theta}{\cos\theta} = \dfrac{y}{x}$

Radians to Degrees: $\times \dfrac{180}{\pi}$

Degrees to Radians: $\times \dfrac{\pi}{180}$

Arc Length: $s = r\theta$

Bounds for Inverse Trig Functions

$sin^{-1}(\theta)$: $[\frac{-\pi}{2}, \frac{\pi}{2}]$

$cos^{-1}(\theta)$: $[0, \pi]$

$tan^{-1}(\theta)$: $[\frac{-\pi}{2}, \frac{\pi}{2}]$

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Statistics Equations

STAT 1040/1045

Stat 1040/1045 Calculator: funwithstats.bitbucket.io

Histograms

height $= \frac{\text{percentage}}{\text{width}}$

Area Under Normal Curve

$z = \frac{x - \text{average}}{\text{SD}}$

$x = \text{average} + z(\text{SD})$

Linear Regression

rms error $= (\sqrt{1 - r^2})\text{SD}_Y$

slope $= \frac{r(\text{SD}_Y)}{\text{SD}_X}$

Box Models

Intercept $= \text{average}_Y - \text{slope}(\text{average}_X)$

$\text{SD}_{1-0 \text{ box}} = \sqrt{(\text{proportion of 1s}) \times (\text{proportion of 0s})}$

$\text{EV}_{\text{sum}} = (\text{number of draws}) \times (\text{average of the box})$

$\text{SE}_{\text{sum}} = \text{SD}_{\text{box}} \times \sqrt{\text{number of draws}}$

$\text{EV}_{\%} = \%$ of 1s in the box

$\text{SE}_{\%} = \frac{\sqrt{\text{number of draws}} \times \text{SD}_{\text{box}}}{\text{number of draws}} \times 100\%$ or $\text{SE}_{\%} = \frac{\text{SD}}{\sqrt{\#\text{ of draws}}} \times 100\%$

$\text{EV}_{\text{avg}} = \text{avg}_{\text{box}}$

$\text{SE}_{\text{avg}} = \frac{\sqrt{\text{number of draws}} \times \text{SD}_{\text{box}}}{\text{number of draws}}$ or $\text{SE}_{\text{avg}} = \frac{\text{SD}}{\sqrt{\#\text{ of draws}}}$

Hypothesis Tests

$z = \frac{\text{observed} - \text{expected}}{\text{SD}}$

$\text{SD}^{+} = \sqrt{\frac{\text{sample size}}{\text{sample size} - 1}} \times \text{SD}$

$\text{SE}_{\text{diff}} = \sqrt{(\text{SE}_A)^2 + (\text{SE}_B)^2}$

$\chi^2 = \text{sum of} \frac{(\text{observed count - expected count})^2}{\text{expected count}}$

Expected Count = $\frac{(\text{row total})(\text{column total})}{(\text{table total})}$

STAT 3000

Distributions

Normal: $E(X) = \mu$ $\quad Var(X) = \sigma^2$

Binomial: $E(X) = np$ $\quad Var(X) = np(1-p)$

Poisson: $E(X) = \mu$ $\quad Var(X) = \mu$

Exponential: $E(X) = \frac{1}{\lambda}$ $\quad Var(X) = \frac{1}{\lambda^2}$

Geometric: $E(X) = \frac{1}{p}$ $\quad Var(X) = \frac{1-p}{p^2}$

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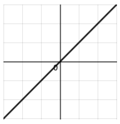
Algebra Notes

Common Relations

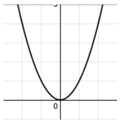
Linear:

Function: $f(x) = ax + b$
Parent Function: $f(x) = x$



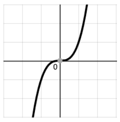
Parabola:

Function: $f(x) = ax^2 + bx + c$
Parent Function: $f(x) = x^2$



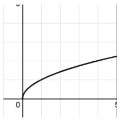
Cubic:

Function: $f(x) = ax^3 + bx^2 + cx + d$
Parent Function: $f(x) = x^3$



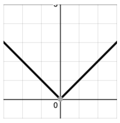
Square Root:

Function: $f(x) = a\sqrt{x - b} + c$
Parent Function: $f(x) = \sqrt{x}$



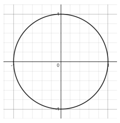
Absolute Value:

Function: $f(x) = a|x - h| + k$
Parent Function: $f(x) = |x|$



Circle:

Equation: $(x-h)^2 + (y-k)^2 = r^2$
Parent Function: $x^2 + y^2 = 1$



Useful Formulas

Distance Formula: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Midpoint Formula: $midpoint = (\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2})$

Quadratic Formula: $x = \frac{-b \pm \sqrt{b^2 - 4(a)(c)}}{2(a)}$

Exponent Rules

Product: $(x^a)(x^b) = x^{a+b}$ **Quotient:** $\frac{x^a}{x^b} = x^{a-b}$

Power: $(x^a)^b = x^{ab}$ **Negative Exponents:** $x^{-a} = \frac{1}{x^a}$

Logarithmic Rules

Product: $\ln(ab) = \ln(a) + \ln(b)$ **Quotient:** $\ln(\frac{a}{b}) = \ln(a) - \ln(b)$

Log of Power: $\ln(a^b) = b\ln(a)$ **Base Change:** $\frac{\ln(a)}{\ln(b)} = \log_b(a)$

Natural Log of e: $\ln(e) = 1$ **Log of 1:** $\log(1) = 0$

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Calculus Equations

Calculus I

Derivative Rules

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

Power Rule: $\frac{d}{dx}(x^n) = nx^{n-1}$

Product Rule $\frac{d}{dx}(f(x)g(x)) = f'(x)g(x) + f(x)g'(x)$

Quotient Rule $\frac{d}{dx}\frac{f(x)}{g(x)} = \frac{g(x)f'(x) - f(x)g'(x)}{(g(x))^2}$

Chain Rule $\frac{d}{dx}f(g(x)) = f'(g(x)) \cdot g'(x)$

U Substitution $\int f(g(x))g'(x)dx = \int f(u)du$, where, $u = g(x)$

Calculus II

Integration by Parts: $\int u\, dv = uv - \int v\, du$
Pick u: Logs, Inverse, Algebraic, Trig, Exponential

Distance From Point to Line: $D = \frac{\left|\left|\overrightarrow{PM} \times \vec{v}\right|\right|}{||\vec{v}||}$

Distance From Point to Plane: $D = \left|\left|proj_n \overrightarrow{QP}\right|\right| = \frac{|\overrightarrow{QP} \cdot \vec{n}|}{||\vec{n}||}$

Unit Tangent Vector: $\vec{T}(t) = \frac{\vec{r}'(t)}{||\vec{r}'(t)||}$

Unit Normal Vector: $\vec{N}(t) = \frac{\vec{T}'(t)}{\left|\left|\vec{T}'(t)\right|\right|}$

Curvature: $\kappa = \frac{\left|\left|\vec{T}'(t)\right|\right|}{||\vec{r}'(t)||}$ $\quad \kappa = \frac{||\vec{r}'(t) \times \vec{r}''(t)||}{||\vec{r}'(t)||^3}$

Tangential Component of Acceleration: $a_T = \frac{\vec{r}'(t) \cdot \vec{r}''(t)}{|\vec{r}'(t)|}$

Normal Component of Acceleration: $a_N = \frac{|\vec{r}'(t) \times \vec{r}''(t)|}{|\vec{r}'(t)|}$

Dot Product: $\vec{a} \cdot \vec{b} = \sum_{i=1}^{n} a_i b_i$

Cross Product: $A \times B = (||A||\, ||B|| \sin\theta)\vec{n}$

Vector Calculus

Arc Length: $L = \int_a^b \sqrt{[f'(t)]^2 + [g'(t)]^2} dt \quad L = \int_a^b ||\vec{r}'(t)||\, dt$

Vector Form of a Line: $\vec{r} = \vec{r_0} + t\vec{v} = \langle x_0, y_0, z_0 \rangle + t\langle a, b, c \rangle$

Symmetric Equation of a Line: $\frac{x - x_0}{a} = \frac{y - y_0}{b} = \frac{z - z_0}{c}$

Parametric form of a Line: $x = x_0 + ta \quad y = y_0 + tb \quad z = z_0 + tc$

Cartesian to Polar Conversion: $x = r\cos\theta \quad y = r\sin\theta$

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