TRIGONOMETRY MNEMONIC TABLE

SOH CAH TOA & DIFFERENTIATION GUIDE

PART 1: SOH CAH TOA - The Basic Trig Ratios

Right Triangle Anatomy

```
       /|
      / |
     /  | Opposite (to angle θ)
    /   |
   / θ  |
  /_____|
  Adjacent

  Hypotenuse = longest side (opposite the 90° angle)
```

The Mnemonic: SOH CAH TOA

Pronounced: "soak-a-toe-uh" (like Krakatoa)

Letter Code	Meaning	Formula	What It Does
SOH	**S**ine = **O**pposite/**H**ypotenuse	$\sin(\theta) = O/H$	Finds the ratio of the side opposite to the angle over the hypotenuse
CAH	**C**osine = **A**djacent/**H**ypotenuse	$\cos(\theta) = A/H$	Finds the ratio of the side adjacent to the angle over the hypotenuse
TOA	**T**angent = **O**pposite/**A**djacent	$\tan(\theta) = O/A$	Finds the ratio of the side opposite to the angle over the adjacent side

Memory Tricks

- **"Some Old Horses Chew Apples Happily Throughout Old Age"**
- **"Some Old Hippy Caught Another Hippy Tripping On Acid"**
- **"Studying Our Homework Can Always Help To Obtain Achievement"**

PART 2: The Complete Trigonometric Functions

Function	Abbreviation	Formula	Reciprocal Of
Sine	sin θ	Opposite / Hypotenuse	cosecant
Cosine	cos θ	Adjacent / Hypotenuse	secant
Tangent	tan θ	Opposite / Adjacent	cotangent
Cosecant	csc θ	Hypotenuse / Opposite	sine
Secant	sec θ	Hypotenuse / Adjacent	cosine
Cotangent	cot θ	Adjacent / Opposite	tangent

Alternative Formulas:

- tan θ = sin θ / cos θ
- cot θ = cos θ / sin θ = 1 / tan θ

PART 3: DIFFERENTIATION OF TRIGONOMETRIC FUNCTIONS

The Six Basic Derivatives

Function	Derivative	Memory Note
sin x	**cos x**	Sine becomes cosine
cos x	**-sin x**	Cosine becomes NEGATIVE sine (note the minus!)
tan x	**$\sec^2 x$**	Tangent becomes secant squared
csc x	**-csc x cot x**	Cosecant becomes NEGATIVE (cosecant × cotangent)
sec x	**sec x tan x**	Secant becomes (secant × tangent)
cot x	**$-\csc^2 x$**	Cotangent becomes NEGATIVE cosecant squared

Pattern Recognition: The CO-FUNCTIONS Rule

All "co-functions" (cosine, cosecant, cotangent) have NEGATIVE derivatives!

```
POSITIVE derivatives:  sin, tan, sec
NEGATIVE derivatives:  cos, csc, cot
```

PART 4: HOW DIFFERENTIATION WORKS - THE PATTERN

The Derivative Cycle for sin and cos

```
sin x  →  cos x  →  -sin x  →  -cos x  →  sin x  (repeats every 4 derivatives)
  d¹      d²        d³        d⁴        d⁵
```

Visual Pattern Table

Original	1st Derivative	2nd Derivative	3rd Derivative	4th Derivative
sin x	cos x	-sin x	-cos x	sin x
cos x	-sin x	-cos x	sin x	cos x

Key Insight: Every 4th derivative returns you to the original function!

PART 5: DIFFERENTIATION USING CHAIN RULE

When you have a function inside the trig function, use the **chain rule**:

Formula Pattern

```
d/dx [trig(u)] = [derivative of trig] × [derivative of u]
```

Examples

Function	Derivative	Steps
sin(3x)	3 cos(3x)	cos(3x) × 3
$\cos(x^2)$	$-2x \sin(x^2)$	$-\sin(x^2) \times 2x$
tan(5x)	$5 \sec^2(5x)$	$\sec^2(5x) \times 5$
sin(2x + 1)	2 cos(2x + 1)	cos(2x + 1) × 2

PART 6: QUADRANT SIGNS - "ALL STUDENTS TAKE CALCULUS"

Which trig functions are POSITIVE in each quadrant:

```
Quadrant II        | Quadrant I
  (Sin)            |   (All)
  sin > 0          | all > 0
___________________|___________________
Quadrant III       | Quadrant IV
  (Tan)            |  (Cos)
  tan > 0          | cos > 0
```

Mnemonic: A-S-T-C (counterclockwise from Quadrant I)

- **A**ll (Quadrant I) - all functions positive
- **S**tudents (Quadrant II) - only Sine positive
- **T**ake (Quadrant III) - only Tangent positive
- **C**alculus (Quadrant IV) - only Cosine positive

PART 7: QUICK REFERENCE - DERIVATIVE FORMULAS

Standard Notation

```
d/dx(sin x) = cos x
d/dx(cos x) = -sin x
d/dx(tan x) = sec²x

d/dx(csc x) = -csc x cot x
d/dx(sec x) = sec x tan x
d/dx(cot x) = -csc²x
```

Prime Notation

```
(sin x)' = cos x
(cos x)' = -sin x
(tan x)' = sec²x

(csc x)' = -csc x cot x
(sec x)' = sec x tan x
(cot x)' = -csc²x
```

PART 8: COMMON MISTAKES TO AVOID

❌ **WRONG**: Mislabeling "adjacent" as any side touching θ (it can't be the hypotenuse!) ✅ **RIGHT**: Adjacent is the leg touching θ (not the hypotenuse)

❌ **WRONG**: Forgetting the negative sign: d/dx(cos x) = sin x ✅ **RIGHT**: d/dx(cos x) = **-sin x**

❌ **WRONG**: Using degrees when you need radians ✅ **RIGHT**: Always check calculator mode (DEG vs RAD)

❌ **WRONG**: Confusing $\cos(x^2)$ with $(\cos x)^2$ ✅ **RIGHT**: $\cos(x^2)$ means "cosine of x-squared" vs $\cos^2(x)$ means "cosine squared"

BONUS: For OBINexus Polar Coordinate System

Converting Between Systems

Cartesian (x, y) → Polar (r, θ):

```
r = √(x² + y²)
θ = arctan(y/x)
```

Polar (r, θ) → Cartesian (x, y):

```
x = r cos(θ)
y = r sin(θ)
```

This is why **SOH CAH TOA matters for your angle-first navigation system** - the polar coordinates define position by:

1. **Angle θ first** (which direction to face)
2. **Distance r** (how far to go)

Instead of corners (x, y grid), you use **rotation** (θ) and **radius** (r) - pure π-geometry! 🔄

"Think of pi as 3.14... but to the position of π to 90 decimal precision - no corners, only curves."