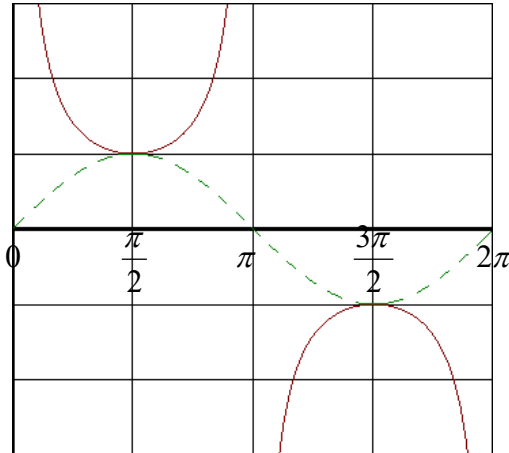


## 4.6 Graphs of the Other Trigonometric Functions

Now we will look at other types of graphs:  $\tan x$ ,  $\cot x$ ,  $\csc x$ ,  $\sec x$ . We will start with the cosecant and secant since it follows from the previous section.

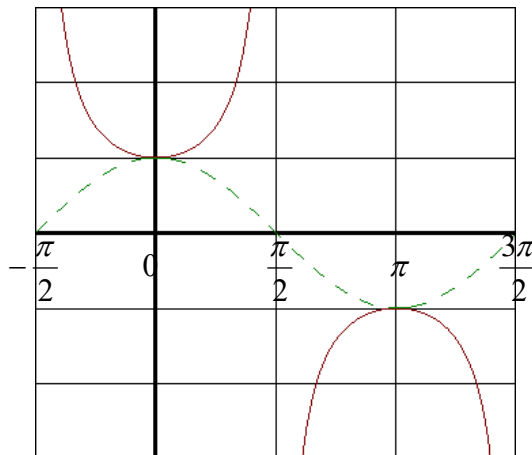
Graph of  $y = \csc x$



In order to draw this graph we will first start with the graph of  $y = \sin x$  (dotted line). Wherever the graph  $y = \sin x$  crosses the x-axis is where there is a vertical asymptote.

The period of  $y = \csc x$  is  $2\pi$ . The amplitude is 1, since the graph touches  $y = \sin x$  at its amplitude.

Graph of  $y = \sec x$



In order to draw this graph we will first start with the graph of  $y = \cos x$  (dotted line). Wherever the graph  $y = \cos x$  crosses the x-axis is where there is a vertical asymptote.

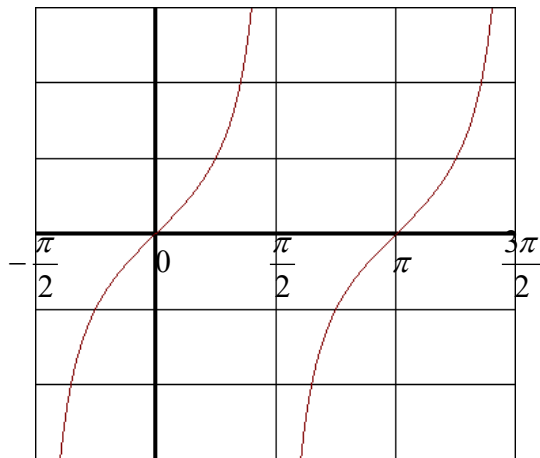
The period of  $y = \sec x$  is  $2\pi$ . The amplitude is 1, since the graph touches  $y = \cos x$  at its amplitude.

EXAMPLE: Graph  $y = 2 \sec\left(\frac{x}{3}\right)$  over one period.

EXAMPLE: Graph  $y = -3 \csc\left(x - \frac{\pi}{4}\right)$  over one period.

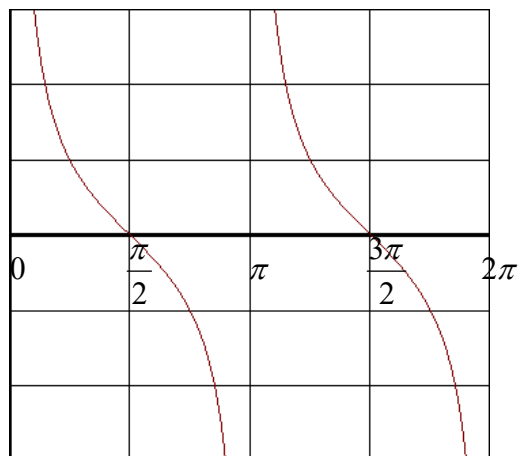
EXAMPLE: Graph  $y = -\frac{1}{3}\sec(2\pi x)$  over one period.

Graph of  $y = \tan x$



The period is  $\pi$ . There are vertical asymptotes at  $x = \frac{n\pi}{2}$  where  $n$  is any integer.

Graph of  $y = \cot x$



The period is  $\pi$ . There are vertical asymptotes at  $x = n\pi$  where  $n$  is any integer. Notice the graph goes the opposite direction as the tangent graph.

**General Form of a Tangent or Cotangent Equation:**

$$y = A \tan(Bx - C) \text{ or } y = A \cot(Bx - C)$$

**Period** =  $\frac{\pi}{B}$    **Half point** =  $\frac{\text{period}}{2}$ . The  $A$  value is a vertical stretch. Tangent and cotangent graphs do not have an amplitude.

$$\text{Phase Shift for tangent} = \frac{C}{B} - \frac{\pi}{2B} \quad \text{where } y = A \tan(Bx - C)$$

$$\text{Phase Shift for cotangent} = \frac{C}{B} \quad \text{where } y = A \cot(Bx - C)$$

EXAMPLE: Find the period and phase shift for  $y = 3 \tan\left(\frac{1}{2}x + \frac{\pi}{3}\right)$

EXAMPLE: Find the period and phase shift for  $y = -2 \cot\left(\frac{3\pi}{4}x - \frac{\pi}{6}\right)$

EXAMPLE: Graph  $y = \tan\left(x + \frac{\pi}{4}\right)$  over 2 periods.

EXAMPLE: Graph  $y = 4 \tan\left(\frac{\pi}{3}x\right)$  over 2 periods.

EXAMPLE: Graph  $y = -3 \tan\left(3x - \frac{\pi}{2}\right)$  over 2 periods.

EXAMPLE: Graph  $y = -\cot\left(x - \frac{\pi}{2}\right)$  over two periods.

EXAMPLE: Graph  $y = \cot\left(\frac{1}{2}x\right)$  over two periods.

EXAMPLE: Graph  $y = -2 \cot\left(2x + \frac{\pi}{3}\right)$  over 2 periods.