

SIGNS AND GRAPHS OF TRIGONOMETRIC FUNCTIONS

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Introduction



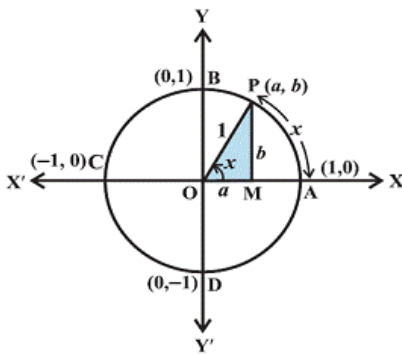
As done in coordinate geometry, the coordinate axes divide the coordinate plane into four [quadrants](#)

. They are named as I quadrant, II quadrant, III quadrant and IV quadrant.

Now we will learn about the pattern of trigonometric ratios:

We have six [trigonometric ratios](#):

Sine (Sin), Cosine (Cos), Tangent (Tan), Cosecant (Cosec), Secant (Sec), Cotangent (Cot)



We will discuss about trigonometric function in detail using [Unit Circle](#):

Consider a unit circle with centre at origin of the coordinate axes. Let P (a, b) be any point on the circle with $\angle AOP = x$ [radian](#), i.e., length of arc AP = x

We define $\cos x = a$ and $\sin x = b$ - (i)

In $\triangle OMP$ is a right triangle, by [Pythagoras theorem](#) we have,

$$OM^2 + MP^2 = OP^2$$

$$a^2 + b^2 = 1 \text{ (from (i))}$$

Thus, for every point on the unit circle, we have

$$a^2 + b^2 = 1 \text{ or } \cos^2 x + \sin^2 x = 1$$

Since one complete revolution subtends an angle of 2π radian at the centre of the circle,

$$\angle AOB = \pi, \angle AOC = \pi \text{ and } \angle AOD = 3\pi/2$$

All angles which are multiples of $\pi/2$ are called [quadrantal angles](#).

The coordinates of the points A, B, C and D are respectively (1, 0), (0, 1), (-1, 0) and (0, -1).

So, we have,

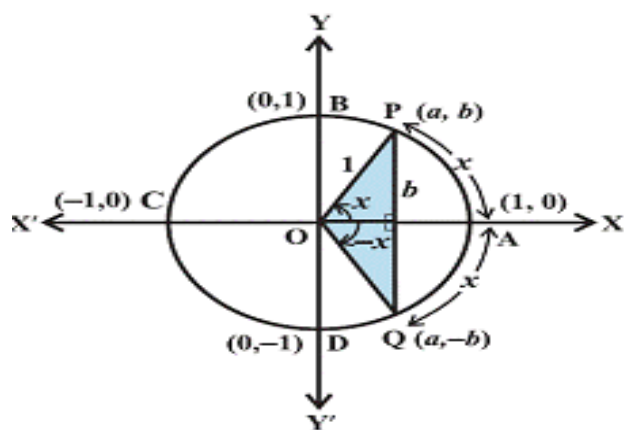
$$\cos 0^\circ = 1 \quad \sin 0^\circ = 0$$

$$\cos \frac{\pi}{2} = 0 \quad \sin \frac{\pi}{2} = 1$$

$$\cos \pi = -1 \quad \sin \pi = 0$$

$$\cos \frac{3\pi}{2} = 0 \quad \sin \frac{3\pi}{2} = -1$$

$$\cos 2\pi = 1 \quad \sin 2\pi = 0$$



Signs of Trigonometric Functions

Now we will discuss about the signs of trigonometric ratios in different quadrant.

I quadrant

I quadrant lies between the coordinates A (1, 0) and B (0, 1).

Also, in the first quadrant ($0 < x < \frac{\pi}{2}$) a and b are both positive.

So, in I quadrant – All trigonometric ratios are positive.

II quadrant

II quadrant lies between the coordinates B (0, 1) and C (-1, 0)

In II quadrant ($\frac{\pi}{2} < x < \pi$) a is negative and b is positive.

So, in II quadrant – Sine and Cosecant are positive rest all are negative.

III quadrant

III quadrant lies between the coordinates C (-1, 0) and D (0, -1)

In III quadrant ($\pi < x < \frac{3\pi}{2}$) a and b both are negative.

So, in III quadrant – Tangent and Cotangent are positive rest all are negative.

IV quadrant

IV quadrant lies between the coordinates D (0, -1) and A (1, 0)

In IV quadrant ($3\pi/2 < x < 2\pi$) a is positive and b is negative.

So, in IV quadrant – Cosine and Secant are positive rest all are negative.

Important Remark:

We have a simple aid to memorise the signs of trigonometric ratios in different quadrants.

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I II III IV

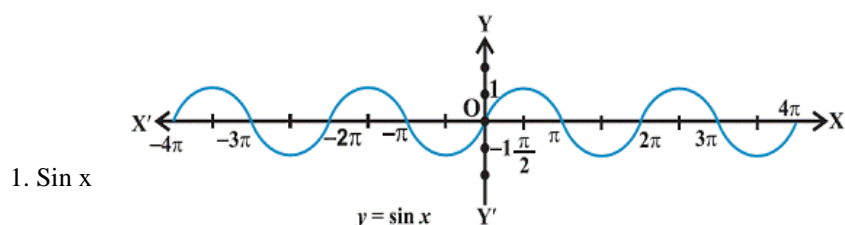
- Letter 'A' states that all trigonometric ratios are positive in the I quadrant.
- Letter 'S' states that only Sine and its reciprocal are positive in the II quadrant.
- Letter 'T' states that only Tangent and its reciprocal are positive in the III quadrant.
- Letter 'C' states that only Cosine and its reciprocal are positive in the IV quadrant.

Graphs of Trigonometric Functions

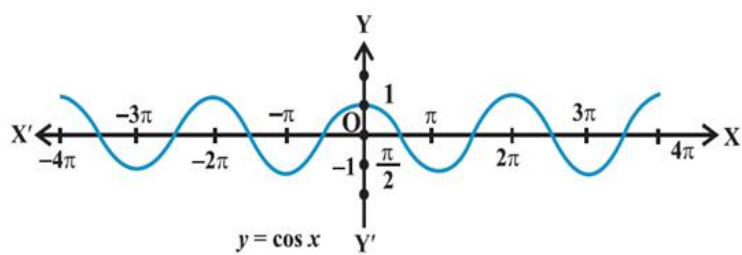
	I quadrant	II quadrant	III quadrant	IV quadrant
sin	increases from 0 to 1	decreases from 1 to 0	decreases from 0 to -1	increases from -1 to 0
cos	decreases from 1 to 0	decreases from 0 to -1	increases from -1 to 0	increases from 0 to 1
tan	increases from 0 to ∞	increases from $-\infty$ to 0	increases from 0 to ∞	increases from $-\infty$ to 0
cot	decreases from ∞ to 0	decreases from 0 to $-\infty$	decreases from ∞ to 0	decreases from 0 to $-\infty$
sec	increases from 1 to ∞	increases from $-\infty$ to -1	decreases from -1 to $-\infty$	decreases from ∞ to 1
cosec	decreases from ∞ to 1	increases from 1 to ∞	increases from $-\infty$ to -1	decreases from -1 to $-\infty$

The above table is based on the observations of different trigonometric ratios in respective quadrants.

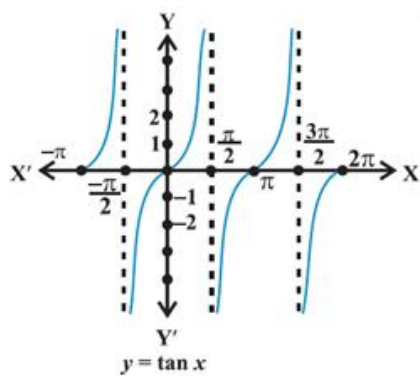
From this, we can have the [graphs of each trigonometric ratio](#) mentioned in the above table.



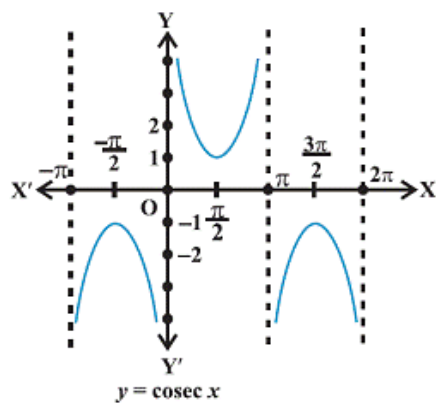
2. $\cos x$



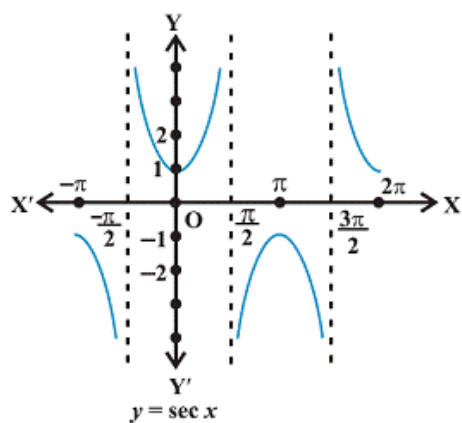
3. $\tan x$

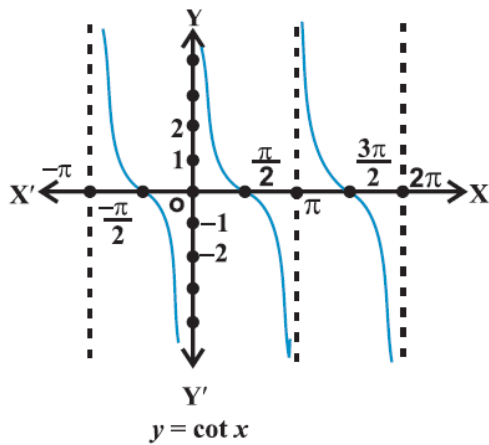


4. $\operatorname{cosec} x$



5. $\sec x$





6. Cot x

Now try it yourself! Should you still need any help, [click here](#) to schedule live online session with e Tutor!

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Reference Links:

- http://wiki.answers.com/Q/What_are_quadrants_of_a_graph
- <http://www.purplemath.com/modules/basirati.htm>
- http://en.wikipedia.org/wiki/Unit_circle
- <http://en.wikipedia.org/wiki/Radian>
- http://en.wikipedia.org/wiki/Pythagorean_theorem
- <http://www.mathopenref.com/trigquadrantal.html>
- <http://www.purplemath.com/modules/grphtrig.htm>

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