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SIGNS AND GRAPHS OF TRIGONOMETRIC FUNCTIONS

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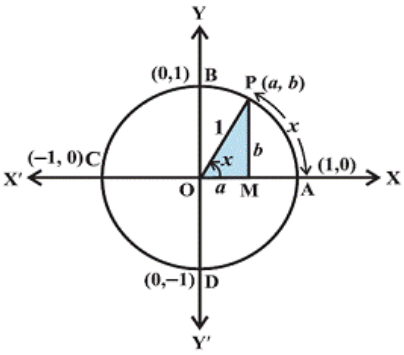
Introduction

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 usingUnit Circle:

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

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

In ? OMP is a right triangle, by Pythagoras theorem we have,

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

$a^2 + b^2 = 1$ (from (i))

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

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

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

?AOB = ?2 , ?AOC = ? and ?AOD = 3?2

All angles which are multiples of ?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).

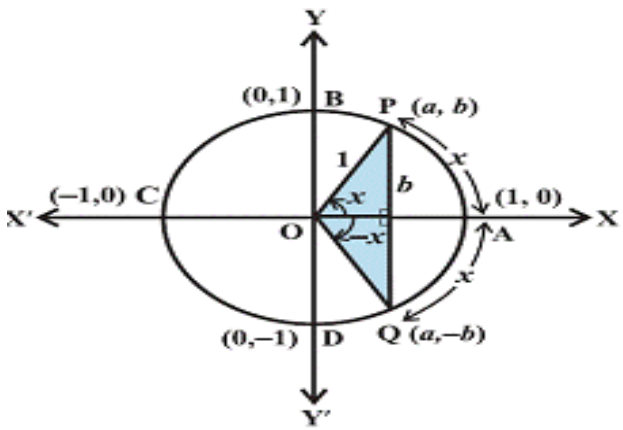
So, we have,
Cos 0° = 1 Sin 0° = 0

Cos ?2 = 0 Sin ?2 = 1

Cos ? = - 1 Sin ? = 0

Cos 3?2 = 0 Sin 3?2 = -1

Cos 2? = 1 Sin 2? = 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< ?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 (?2 < x < ?) 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 (? < x < 3?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?2< x < 2?) 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.

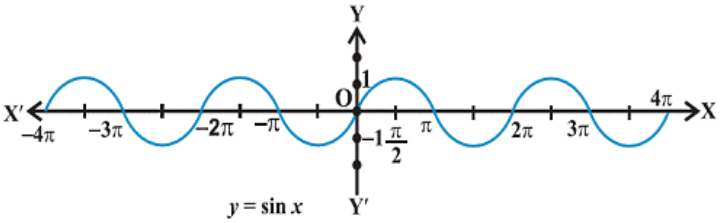
Graphs of Trigonometric Functions

	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 –∞to 0	increases from 0 to ∞	increases from –∞to 0
cot	decreases from ∞ to 0	decreases from 0 to–∞	decreases from ∞ to 0	decreases from 0to –∞
sec	increases from 1 to ∞	increases from –∞to–1	decreases from –1to–∞	decreases from ∞ to 1
cosec	decreases from ∞ to 1	increases from 1 to ∞	increases from –∞to–1	decreases from–1to–∞

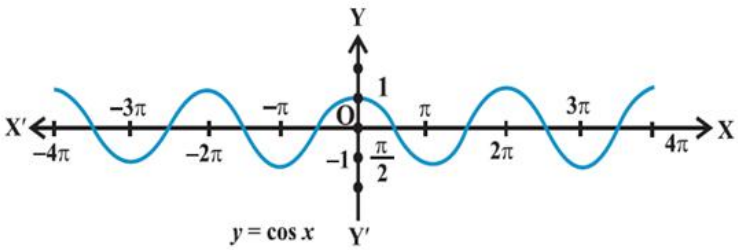
The above table is based on the observations of different trigonometric ratios in respective quadrants.

From this, we can have the graphs of each trigonometric ratio mentioned in the above table.

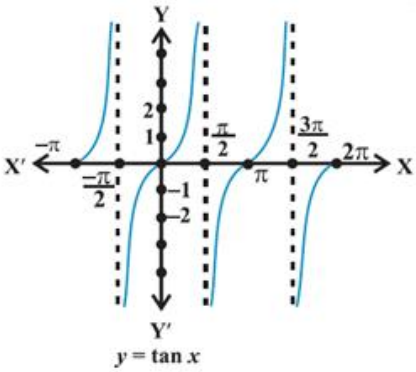
1. Sin x



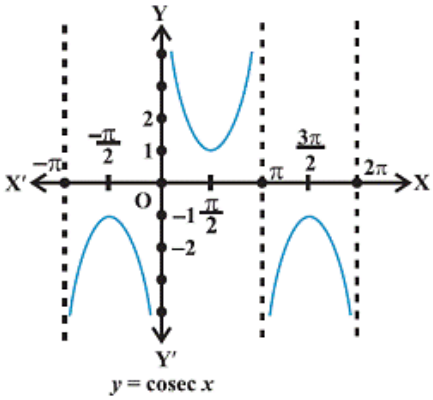
2. Cos x



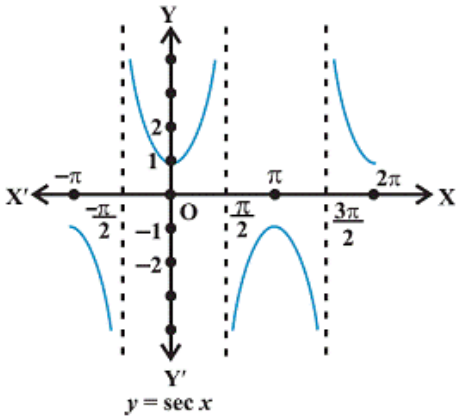
3. Tan x



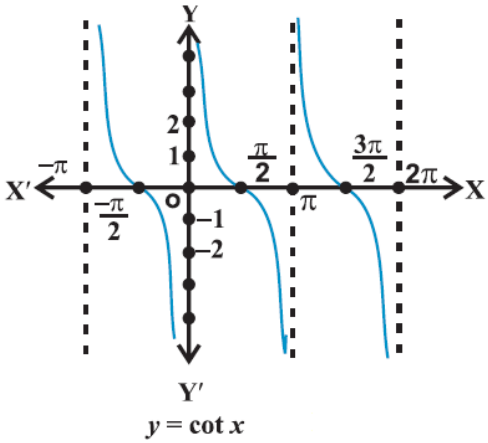
4. Cosec x



5. Sec x



6. Cot x



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Reference Links:

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- 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
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