Lab 4

Trigonometric Functions

Aim:

- To create an applet to find the values of trigonometric functions and plot their graphs

- To establish some behaviours of trigonometric functions in different quadrants

Concepts:

- Concept of circular functions **HSSLiVE.IN**

- Graph of the function f is a collection of points of the form $(a, f(a))$ for all values of a in its domain

Discussion :

If a point is rotated from $(1, 0)$ along the unit circle centred at the origin, by an angle x radians, the x and y coordinates of the point represent $\cos x$ and $\sin x$ respectively. We define all other trigonometric functions in terms of $\cos x$ and $\sin x$. We use this idea to construct our applet.

## Activity 4.1 Values of Trigonometric Functions

Procedure:

Open a new GeoGebra window,do some initial settings as follows
`Options→ Advanced → Angle unit → Radian`

- Plot the point $O(0, 0)$ (input `O=(0,0)`)

- Draw a unit circle centred at the origin O

- Plot the point $A(1, 0)$ (input `A=(1,0)`)

- Create a number slider **a** with min value -10 , max value 10 and increment 0.01. While creating the slider, set its animation as increasing

- Plot another point A' such that $\angle\,AOA' = $ **a** radian

- Rename the point A' as P (right click → Rename)

- Show the coordinates of P

- Join OP using a line segment

- Create an input box for the slider **a**.

👉
- To set the animation of a slider as increasing, right click on the slider and in the object properties, select increasing option from the repeat dropdown menu

- To create an angle AOA' with measurement a, use *Angle with a given size* tool, click on A, O and then give **a** as the angle in the box
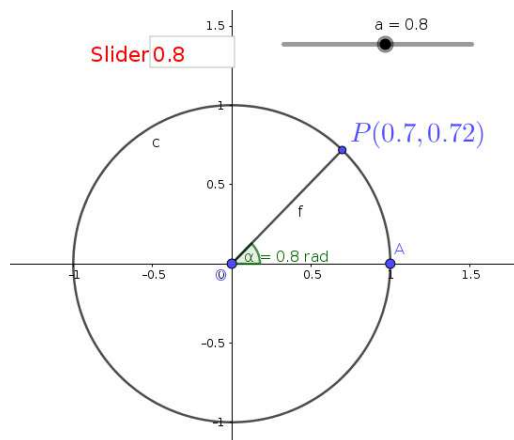
- 📖 Animate the slider,observe the coordinates of the point P, hence find the domain and range of $\sin x$ and $\cos x$

- 📖 Find the values of $\sin x$ and $\cos x$ for the given values of x

x	$\frac{\pi}{3}$	$\frac{\pi}{4}$	$\frac{\pi}{6}$	$\frac{\pi}{2}$	0.3	0.6	2	-1.5	-3.1	7.5
$\sin x$										
$\cos x$										

👉 For giving π in the input box, input:pi

📖 Identify the values of x for which $\sin x$ and $\cos x$ become 0,1,-1

- Save this file as Activity 4.1

Activity 4.2 Graphs of Trigonometric Functions - 1

Procedure:

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- Save file Activity 4.1 as Activity 4.2 using save as option

- Open Graphics 2 [`view` ⟶ Graphics 2]

- Plot the point $B(a, y(P))$. [$y(P)$ gives the y coordinate of P]

- Give trace to this point and animate the slider

- 📖 Observe the path of this point. What does this path represent?

- Save the file.

👉
- We can see the path of the point using locus tool also.To get the path,take the locus tool, click on the point and on the slider

- For analysing the graphs of trigonometric functions, it is more convenient to mark $\cdots \frac{-\pi}{2}, 0, \frac{\pi}{2} \cdots$ on the x axis instead of ...-1 ,0 ,1...
(For this right click on the Graphics 2. Go to *Object Properties* Change the x Axis distance to $\frac{\pi}{2}$)

- We can draw the graphs of $\sin x$ and $\cos x$ using input commands sin(x), cos(x) *etc.*

Activity 4.3 Graphs of Trigonometric Functions - 2

Procedure:

- Open Activity 4.2 and save as Activity 4.3 using save as option

- Create an input box for the point B

- Change the definition of B as $(a, x(P))$

- Observe the path of this point

- What does this path represent?

- Redefine B as $(a, \frac{1}{y(P)})$ and $(a, \frac{y(P)}{x(P)})$, observe the path of P and identify the functions.

- What should be the definition of B for getting the graphs of $\sec x$ and $\cot x$?

- Observe the values of trigonometric functions, write their domain, range and complete the following table.

Function	$\left(0, \frac{\pi}{2}\right)$	$\left(\frac{\pi}{2}, \pi\right)$	$\left(\pi, \frac{3\pi}{2}\right)$	$\left(\frac{3\pi}{2}, 2\pi\right)$
$\sin x$	Positive			
	Increasing from 0 to 1			
$\cos x$				
$\tan x$				
			Increasing from 0 to ∞	
$\sec x$				
$\cot x$				
$\operatorname{cosec} x$				

Additional Activities

Activity 4.A $k \sin(x)$

Discussion :

We construct an applet similar to that in Activity 4.1, using which we describe the functions $k \sin(x), k \cos(x)$ *etc.* for different values of **k**.

Procedure :

Do the initial settings as in activity 4.1

- Create two sliders, **k** with Min = 0 and **a** with min value -10 , max value 10 and increment 0.01.While creating the slider **a**, set its animation as increasing

- Draw a circle of radius **k** centered at the origin O(0,0)

- Plot the point $A(k, 0)$

- Plot another point A' such that $\angle AOA' = $ **a** radian

- Rename the point A' as P

- Show the coordinates of P

- Join OP using a line segment

- 📖   What does the coordinates of the point P represent ?

- 📖   Find the domain and range of $k \sin(x)$ and $k \cos(x)$ for different values of **k**

- Open Graphics 2 and plot the graphs of $k \sin(x)$ and $k \cos(x)$ as we done in Activity 4.2.

- Save this file as Activity 4.A

Activity 4.B $k \sin(2x)$

Discussion :

We construct an applet using which we describe the functions $k \sin(2x), k \cos(2x)$ *etc.*

Procedure :

- Open Activity 4.A and save it as Activity 4.B

- edit the rotation of P as **2a** (Double click and edit)

- 📖   What does the coordinates of the point P represent ?

- Open Graphics 2 and plot the graphs of $k \sin(2x)$ and $k \cos(2x)$

- Create an applet to describe $k \sin(ax)$ and $k \cos(ax)$, for different values of **k** and **a**