Basic Concepts

Aim

- To familiarise the GeoGebra interface and Toolbar.
- To familiarise the concept of domain, range and graphs of standard functions.

Concepts

- Domain, range and graphs of functions.

Activity 0.1 GeoGebra Interface

Procedure:

- Familiarise the interfaces of GeoGebra
- Familiarise the Toolbar and some important tools of GeoGebra.

Activity 0.2 Graph of a function

Procedure:

- Create a slider a with increment 1 as follows.

Using **Slider** tool click any where on the **Graphics View** we get a window in which we can edit the name, minimum value, maximum value, and increment of the slider.

- Plot the point $A(a, a^2)$. (Input : A = (a, a^2) or (a, a^2))
- Change the value of the slider and observe the movement of A.

We can change the value of a slider in different ways.

- Click and drag the slider point.
- Using Move tool click on the slider point and then use arrow key to change the value.
- Right click on the slider and select **Animation On**.
- Create an input box for the slider and change the value.

Ans:- Q₁) Observe the curve traced. What does it represent?

It represents the graph of $y = x^2$

Q₂) Observe the curve traced. What does it represent?

It represents the graph of $y = x^3$

Q₃)

The definition become $A = (a, a^4)$

- Change the increment of the slider to 0.01. (Right click on the slider → object properties → Slider → Enter 0.01 in the Increment box)
- Observe the movement of the point.
- Trace the point A. (Right click on the point → Trace on)

Q₁) Observe the curve traced. What does it represent?

- Create an Input Box for the point A.
- Change the definition of the point A as (a, a^3). (In the Input Box enter (a,a^3))

Q₂) Observe the curve traced. What does it represent?

Q₃) What should be the definition of the point A, so that the curve represents the graph of the function $f(x) = x^4$?

Activity 0.3 Standard Functions

Procedure :

- Draw the graphs of standard functions using Inputs

Functions	Input	Domain	Range
x	x	R	R
x^2	x^2	R	$[0,\infty)$
$\lvert x\rvert$	abs (x)	R	$[0,\infty)$
$\sqrt{x}$	sqrt (x)	$[0,\infty)$	$[0,\infty)$
x^3	x^3	R	R
$[x]$	floor (x)	R	Z
$\frac{1}{x}$	1/x	$R-\{0\}$	$R-\{0\}$
Signum function	Sign (x)	R	$\{-1, 0, 1\}$

Q4) Observe the graph and find its domain and range.

Activity 0.4 Domain and Range

Procedure :

- Create an integer slider n

  (Using **Slider** tool click anywhere on the Graphics → Select Integer → click OK. If we want we can change the minimum, maximum and increment of the slider.)

- Draw the graph of $f(x) = x^n$

  [Input : f(x) = x^n]

Q5) Observe the graph of the function x^n and find the domain and range for different values of n

Q6) What happens to the graph of the function x^n between -1 and 1 as n becomes larger and larger? why?

Q) As 'n' increases, portion of the graph in -1 and 1 approaches more and more close to 'x'-axis

n	Function	Domain	Range
1	x	R	R
2	x^2	R	$[0,\infty)$
3	x^3	R	R
4	x^4	R	$[0,\infty)$
5	x^5	R	R

Lab 1

Value of Function

Aim

- To construct an applet to establish geometrically the correspondance of a number and its image under a function
- To use this applet to find the images of numbers under various functions.
- To use an applet to visualise the comparison of a function with an input-output machine.

Concepts

- Image of a number a under a function f is denoted by $f(a)$
- Graph of the function f is the collection of points $(a, f(a))$

Activity 1.1 Functions

Procedure

- Draw the graph of $f(x) = x^2$
- Create a number slider a with increment 0.01.
- Plot the points $A(a,0)$, $B(a, f(a))$, $C(0, f(a))$ (Give inputs like $A = (a,0)$.)
- Draw the line segments AB and BC using Segment tool.
- Show the coordinates of A, B and C.
- Now drag the point A along the x axis (either click and drag the point or using slider - click and drag the slider point to change the value of a) and observe the movement of C on the y axis.

Ans:-

	$3^{\frac{1}{3}}$	$\sqrt{1.8}$	$2^{\frac{2}{3}}$	$\sqrt{\sqrt{5}}$	$(3.46)^{-\frac{3}{2}}$
Function	$x^{\frac{1}{3}}$	$\sqrt{x}$	$x^{\frac{2}{3}}$	$\sqrt{\sqrt{x}}$	$x^{-\frac{3}{2}}$
Input (x)	3	1.8	2	$\sqrt{5}$	3.46
Value $(f(x))$	1.442	1.342	1.587	1.495	0.155

x coordinate of $(A)^2$ is the y coordinate of C

Ans: Q) $(2.3)^2 = \cancel{4.12}\ \cancel{\ldots})\ 5.29$

$(-1.8)^2 = 3.24$

$(0.9)^2 = 0.81$

$(2.9)^2 = 8.41$

Q) Using this, find the values of $(2.3)^2, (-1.8)^2, (0.9)^2, (2.9)^2 \ldots$

Save the file as Activity 1.1

Activity 1.2 Values of Function

Procedure :

- Open the file Activity 1.1 and save as Activity 1.2
- Create an Input Box for f and change the function using it.
  (Select Input Box tool, → Click on Graphics View → give a suitable caption (say function) → Linked Object → $f(x) = x^2$ → OK)
- Similarly create an Input Box for the slider

Q) Change the functions accordingly and find the approximate values corrected to 3 decimal places of the following.

Ans- balance

$\sin 5$	$\log 4$	e^3
$\sin(x)$	$\log x$	e^x
5	4	3
0.959	0.602	20.086

Ans-Q_9) The point A approaches to 0 from the right of the origin. The point C tends to infinity & the point A approaches to 0 from the left of the origin the point C tends to $-\infty$

Ans-Q_{10}) C moves from integer to integer.

Reason range of the function = Z

Q_9) Change the function to $f(x) = \frac{1}{x}$, and observe how the point C moves as the point A approaches the origin from either side

Q_{10}) Change the function to $f(x) = [x]$ and observe the movement of C according to A.

Activity 1.3 Function Machine

Procedure:

Use Applet ML 1.3

About the Applet

Three switches are provided on the machine

- GREEN :- Click to start the machine
- RED :- Click to stop the machine
- BLUE :- Click to reset

Ans: Q i) $\sqrt{2} = \cancel{1.19}\ 1.41$

ii) $\sqrt{1.8} = \cancel{1.16}\ 1.34$

iii) $\sqrt{2/3} = \cancel{0.91}\ 0.82$

Ans: Q_{12}) $f(x)$ is not defined. Because, domain is $[0, \infty)$

Ans: Q_{13} • i) $\frac{2}{3} = 0.67$

ii) $\frac{-3}{7} = -0.43$

iii) $\sqrt{\frac{2}{3}} = 0.82$

Ans: • Input is 0

function is not defined, Because,

domain $= R - \{0\}$

Using Input Boxes we can change the function and the input number.

The warning light provided on the machine turns red if the input number is out of the domain of the function.

Q_{11}) Change the function to $f(x) = \sqrt{x}$ and find the values of the following.

i) $\sqrt{2}$ ii) $\sqrt{1.8}$ iii) $\sqrt{2/3}$

Q_{12}) What happens if we give a -ve number as the input?

Q_{13}) • Change the function to $f(x) = \frac{1}{x}$ and find the values of the following.

i) $\frac{2}{3}$ ii) $\frac{-3}{7}$ iii) $\sqrt{\frac{2}{3}}$

• What happens if the input is 0?

Lab 2

Shifting of Graphs

Aim

To analyse the changes in the graph of a function according to some slight changes in the definition.

Concepts

- Graph of a function

Activity 2.1 Shifting of graphs : $f(x)+a$

Procedure :

- Draw the graph of $f(x) = x^2$
- Create a number slider 'a' with increment 0.1
- Draw the graph of $g(x) = f(x)+a$ (Input: f+a)

Q14) Observe how the graph of $g(x)$ changes according to a

- Create Input Boxes for editing function and slider 'a'

Q15) Do the above observations for different functions such as $|x|$, $[x]$, x^3 etc

- Save this as Activity 2.1

Ans Q_{14}) The graph of $g(x)$ moves, upward shifting vertically by a unit, if a is +ve, $g(x)$ moves vertically downwards by a unit, if a is -ve

Ans, Q_{15} :-

Function	Domain	Range	Shifting
$\lvert x \rvert$	R	$[0,\infty)$	vertical
$[x]$	R	Z	vertical
x^3	R	R	vertical
x^2	R	$[0,\infty)$	vertical

The graph shift horizontally a unit towards left of the origin when a is +ve and toward right when a is -ve

Activity 2.2 Shifting of graphs : $f(x+a)$

Procedure :

- Open a new GeoGebra window.
- Draw the graph of $f(x) = x^2$.
- Create a number slider 'a' with increment 0.1
- Draw the graph of $g(x) = f(x+a)$. (Input : $f(x+a)$)

Q_{16}) Observe how the graph of $g(x)$ changes according to 'a'..

- Create Input Boxes for the function 'f' and slider 'a'.

Q_{17}) Generalise the above observations with different functions such as $\lvert x \rvert$, $[x]$, x^3 etc.

- You may use the animation option to change the slider
- Save this as Activity 2.2

Activity 2.3 Reflection of a graph

Procedure :

- Open a new GeoGebra window.
- Draw the graph of $f(x) = x^2$
- Draw the graph of $g(x) = -f(x)$ ~~and~~ g. (Input : $-f$)

Q18) Compare the graph of $f(x)$ and $g(x)$

- Create an Input Box for f and change the function to.

(i) x^2+2 (ii) x^2-1 (iii) $|x|-1$

(iv) $|x-1|$ (v) $[x]$ (vi) x^2+2x+1

(vii) $\frac{1}{x}$

Q19) Compare the graph of 'f' and 'g' in each case. Write your findings.

- Save this file as Activity 2.3

Ans Q_{18}) $f(x)$ and $g(x)$ are reflection about x-axis

Function	Domain	Range	Domain of $g(x)$	Range of $g(x)$
x^2+2	R	$[2,\infty)$	R	$(-\infty,-2]$
x^2-1	R	$[1,\infty)$	R	$(-\infty,1]$
$\lvert x\rvert-1$	R	$[-1,\infty)$	R	$(-\infty,1]$
$\lvert x-1\rvert$	R	$[0,\infty)$	R	$(-\infty,0]$
$[x]$	R	Z	R	Z
x^2+2x+1	R	$[0,\infty)$	R	$(-\infty,0]$
$\frac{1}{x}$	R-{0}	R-{0}	R-{0}	R-{0}

Ans Q_{20}) $f(x)$ and $g(x)$ are reflection on y axis

Activity 2.4 Reflection of a graph : $f(-x)$

Procedure :

- Open a new GeoGebra window
- Draw the graph of $f(x) = x^3$
- Draw the graph of $g(x) = f(-x)$ (Input : $f(-x)$)

Q_{20}) Compare the graph of $f(x)$ and $g(x)$

- Create an Input Box for f and change the function

(i) $\frac{1}{x}$ (ii) $[x]$ (iii) $\lvert x\rvert$

(iv) x^2 (v) $(x-2)^2$

Q_{21}) Compare the graph of f and g in each case. Write your findings.

Q20)

	Function	Domain	Range	Domain in $g(x)$	Range of $g(x)$
	$\frac{1}{x}$	$R-\{0\}$	$R-\{0\}$	$R-\{0\}$	$R-\{0\}$
odd	$[x]$	R	Z	R	Z
even	$\|x\|$	R	$[0,\infty)$	R	$[0,\infty)$
even	x^2	R	$[0,\infty)$	R	$[0,\infty)$
neither	$(x-2)^2$	R	$[0,\infty)$	R	$[0,\infty)$

22) for even function reflection is same

23) $|x|$ & x^2 are even function

$\frac{1}{x}$ & $[x]$ are odd function.

24) $(x-2)^2$

Q22) What is the speciality of the graph of odd and even functions?

Q23) Identify odd and even functions discussed in this lab.

Q24) Is there any function which is neither odd nor even?

• Save this file as Activity 2.4.

PLUS ONE FOCUS 2

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Lab 4

Trigonometric Function

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

- To ~~create~~ Concept of circular functions
- Graph of the function f is a collection of points of the form $(a, f(a))$ for all values of a in its domain.

Activity 4.1 - Values of Trigonometric Function

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 $= -10$, max $= 10$ and increment 0.01. While creating the slider, set its animation as increasing
- Plot another point A' such that $\angle AOA' = a$ radial
- Rename the point A' as P (right click → Rename)
- Show the coordinates of P
- Join OP using a line segment

Q1) Domain of $\sin x = R$

Range of $\sin x$ = $[-1, 1]$

Q2) Domain of $\cos x = R$

Range of $\cos x = [-1, 1]$

Q3) ~~Values of x for sin x = 0~~

$\underline{\sin x = 0}$, $x = \pi, 2\pi, 3\pi, 4\pi, -\pi, -2\pi$

$\underline{\sin x = 1}$,

$x = \frac{-3\pi}{2}, \frac{\pi}{2}, \frac{5\pi}{2}, \ldots$

$\underline{\sin x = -1}$,

$x = \frac{-5\pi}{2}, \frac{-\pi}{2}, \frac{3\pi}{2}, \frac{7\pi}{2}, \ldots$

> $\underline{\cos x = 0}$, $x = \frac{-5\pi}{2}, \frac{-3\pi}{2}, \frac{7\pi}{2}, \frac{\pi}{2}, \frac{3\pi}{2}, \ldots$

$\underline{\cos x = 1}$, $x = -2\pi, 0, 2\pi, \ldots$

$\underline{\cos x = -1}$, $x = -3\pi, -\pi, \pi, 3\pi, \ldots$

- Create an input box for the slider a.

Q1) Animate the slider, observe the coordinates of the point P. hence find the domain and range of $\sin x$ and $\cos x$

Q2) 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
$\sin x$	0.87	0.71	0.5	1	0.3	0.56	0.91	-1	-0.04	0.94
$\cos x$	0.5	0.71	0.87	0	0.96	0.83	-0.42	0.09	-1	0.35

Q3) Identify the values of x for which $\sin x$ and $\cos x$ become 0, 1, -1

- Save this file as Activity 4.1

Q) The path of B represent the graph of sin x

Activity 4.2 - Graphs of Trigonometric Function - 1

Procedure :

- 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.

Q) Observe the path of this point. What does this path represent?

- Save the file

Q5&6) The path represent the graph of $\cos x$.

Q7) Redefine B as $\left(a, \frac{1}{y(P)}\right)$, the path of B represent the graph of $\operatorname{cosec} x$

Redefine B as $\left(a, \frac{y(P)}{x(P)}\right)$. The path of B represent the graph of $\tan x$.

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 $(a, x(P))$

Q5) Observe the path of this point?

Q6) What does this path represent?

Q7) Redefine B as $\left(a, \frac{1}{y(P)}\right)$ and $\left(a, \frac{y(P)}{x(P)}\right)$, observe the path of P and identify the functions.

Q8) What should be the definition of B for getting the graphs of $\sec x$ and $\cot x$?

Q) Observe the values of trigonometric functions, write their domain, range and complete the following table

Function	$(0, \frac{\pi}{2})$	$(\frac{\pi}{2}, \pi)$	$(\pi, \frac{3\pi}{2})$	$(\frac{3\pi}{2}, 2\pi)$
Sin x	Positive	Positive	Negative	Negative
	Increasing from 0 to 1	Decreases from 1 to 0	Decreases from 0 to -1	Increases from -1 to 0
Cos x	Positive	Negative	Negative	Positive
	Decrease from 1 to 0	Decreases from 0 to 1	Increases from -1 to 0	Increases from 0 to 1
tan x	Positive	Negative	Positive	Negative
	Increases from 0 to ∞	Increases from -∞ to 0	Increasing from 0 to ∞	Increasing from -∞ to 0
sec x				
Cot x				
Cosec x				

Lab 10

Circle and Parabola

Aim

To explore different methods of drawing Circles and Parabolas using Geogebra tools and commands

Concepts

- Definitions of Circle and Parabola
- Equations of Circle and Parabola

Activity 10.1 - Circle

We can draw a circle in different ways

- Centre and a point on the circle are given
  - Using **Circle with Centre through Point** tool, click on the centre and then on the point
  - Give input in the following manner,
    Circle (centre point, point)
- Centre and radius are given
  - Using **Circle with Centre and Radius** tool, click on the centre and enter radius
  - Give input in the following manner,
    Circle (Point, Radius)

Q) 1) $(x+5)^2+(y-3)^2=36$

Centre $=(-5,3)$

radius $=6$

2) $x^2+y^2-4x-8y-45=0$

$x^2-4x+4+y^2-8y+16=45+16+4$

$(x-2)^2-(y-4)^2=\sqrt{65}^2$

Centre $=(2,4)$

radius $=8.06=\sqrt{65}$

3) $2x^2+2y^2-8=0$

Centre $(0,0)$

radius $=2$

- Three points on the circle are given
  - Using Circle through 3 points tool, click on the points
  - Give Input in the following manner. Circle (Point, Point, Point)
- Input the equation of the circle

  For example: $(x-1)$^2 + $(y-2)$^2 = 4 gives the circle $(x-1)^2+(y-2)^2=4$

Q) Find the centre and radius of the following circles, Draw the circle and verify your answer. You can do it in any of the following ways.

- Draw the circle by direct input of the equation, find its centre and radius. Compare with your answer.

Q) 1) Centre $(-2,3)$, radius $=4$

$C: (x+2)^2+(y-3)^2=16$

2) Centre $(2,2)$ and passing through the point $(4,5)$

$C: (x-2)^2+(y-2)^2=13$

Q) 1) $C: (x-3.5)^2+(y+2.5)^2=32.5$

2) $C: (x-2.67)^2+(y-3.67)^2=5.56$

3) Method

- Draw the perpendicular bisector of $(1,2)$ & $(5,4)$
- Draw the perpendicular bisector of $(5,4)$ & $(3,6)$
- Find the point of intersection of perpend

- Draw the circle using **Circle with Centre and Radius** tool, using the centre and radius that you found. Compare its equation with the given equation

1, $(x+5)^2+(y-3)^2=36$

2, $x^2+y^2-4x-8y-45=0$

3, $2x^2+2y^2-8=0$

Q) Find the equations of the following circles. Input the equations obtained, draw the circles and verify your answer.

1, Centre $(-2,3)$ and radius 4

2, Centre $(2,2)$ and passing through the point $(4,5)$

Q) Construct the following circles without using **Circle through 3 Points** tool or input commands

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dicular bisectors.

- Point of intersection is the centre of the circle
- Using centre point tool, draw the circle

1) Passing through the points $(2,3)$ and $(-1,1)$ and with centre on the line $x-3y-11=0$

2) Passing through the points $(1,2)$ $(5,4)$ and $(3,6)$

3) If three points are given, how can we find the equation of the circle passing through them (without using GeoGebra. Hint: above problem)

Activity 10.2 - Parabola 1

Procedure:

- Using the tool **Parabola** select a line and a point to get a parabola with the line as directrix and the point as focus.
- We can also draw a parabola using input command, for example, the input command Parabola[(2,0), x+2=0] gives

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Q) i) $y^2 = 8x$ focus $= (2,0)$

$y^2 = 4ax$ directrix $= x+2 = 0$

$4a = 8$

$a = 2$

$\Rightarrow$ C: $y^2 - 8x = 0$

ii) $x^2 = 4y$ Focus $(0,1)$

$x^2 = 4ay$ directrix $= y+1 = 0$

$4a = 4$

$a = 1$

d: $x^2 - 4y = 0$

iii) $x^2 = -4y$

$x^2 = 4ay$

$4a = -4$

$a =$

the parabola with focus $(2,0)$ and directrix $x+2=0$

- If A represents a point and f represents a line then the command Parabola [A,f] gives the parabola with focus A and directrix f

Q) Draw a line and plot a point. Draw the corresponding parabola. Change the distance between the line and the point, observe the corresponding change in the shape of the parabola.

Q) Find the focus and directrix of the following parabolas. Using Parabola tool, draw them. Check whether the equation of the parabola that you have drawn is same as the given

i) $y^2 = 8x$ ii) $x^2 = 4y$

iii) $x^2 = -4y$ iv) $y^2 = -10x$

Activity 10.3 - Parabola 2

Procedure :

- By giving the equation of the parabola directly in the input bar, we can draw the parabola
- Create a slider **a** and give the input $y^2 = 4ax$ and $x^2 = 4ay$

Q) Change the value of **a** and observe the shape of the parabolas

Q) Find the focus and length of latus rectum of the following parabolas. Verify your answer geometrically as follows;

Input the equation and draw the parabola. Using focus command(Focus[name of parabola]), we can find its focus. Draw the line through the focus and perpendicular to the axis of the parabola. Mark the points of intersection of this line with the parabola and joins them with a line segment. Hide the line and measure the length of the latus rectum.

i) $y^2 = 6x$ ii) $x^2 = -8y$

iii) $x^2 = 10y$ iv) $y^2 = -4x$

19/06/23

LAB - 0
BASIC CONCEPTS

Aim :

- To familiarise the GeoGebra interface and Toolbar.
- To familiarise the concepts of domain, range and graphs of standard functions.

Concepts

- Domain, range and graphs of functions.

> **Activity 0.1 GeoGebra Interface**

Procedure :

- Familiarise the interfaces of GeoGebra
- Familiarise the Toolbar and some important tools of GeoGebra.

> **Activity 0.2 Graph of a function**

Procedure :

- Create a slider 'a' with increment 1 as follows.
  Using **Slider** tool click any where on the **Graphics** view. We get a window in which we can edit the name, minimum value, maximum value, and increment of the slider.
- Plot the point $A(a, a^2)$. (Input : A = (a, a^2) or (a, a^2)
- Change the value of the slider and observe the change of A
  We can change the value of a slider in different ways.
  - Click and drag the slider point.
  - Using **Move** tool click on the slider point and then use arrow key to change the value.
  - Right click on the slider and select **Animation On**
  - Create an input box for the slider and change the value.

- Change the increment of the slider to 0.01.
  (Right click on the slider → object properties → Slider → Enter 0.01 in the **Increment** box)
- Observe the movement of the point.
- Trace the point A (Right click on the point → Trace on)

Q) Observe the curve traced. What does it represent?

It represent the graph of $y = x^2$

- Create an Input Box for the point A
- Change the definition of the point A as (a, a^3) (In the Input Box enter (a,a^3))

Q) Observe the curve traced. What does it represent?

It represent the graph of $y = x^3$

Q) What should be the definition of the point A, So that the curve represents the graph of the function $f(x) = x^4$?

The definition become $A = (a, a^4)$

> **Activity 0.3 Standard Functions**

Procedure:

- Draw the graph of standard functions using inputs

Functions	Input	Domain	Range
x^2	x^2	R	$[0,\infty)$
x	x	R	R
$\lvert x \rvert$	abs(x)	R	$[0,\infty)$
$\sqrt{x}$	sqrt(x)	$[0,\infty)$	$[0,\infty)$
x^3	x^3	R	R
$[x]$	floor(x)	R	Z
$\frac{1}{x}$	$\frac{1}{x}$	$R-\{0\}$	$R-\{0\}$
Signum function	Sign(x)	R	$\{-1,0,1\}$

Q) Observe the graph and find its domain and range.

> **Activity 0.4 Domain and Range**

Procedure:

- Create an integer slider **n** (Using **Slider** tool click anywhere on the Graphics → Select Integer → click OK. If we want we can change the minimum, maximum and increment of the slider)
- Draw the graph of $f(x) = x^n$ [Input : f(x) = x^n]

Q) Observe the graph of the function x^n and find the domain and range for different values of n

n	Function	Domain	Range
1	x	R	R
2	x^2	R	$[0,\infty)$
3	x^3	R	R
4	x^4	R	$[0,\infty)$
5	x^5	R	R

Q) What happens to the graph of the function x^n between -1 and 1 as **n** becomes larger and larger? Why?

As 'n' increases, position of the graph in -1 and 1 approaches more and more close to x-axis.

26/7/23

LAB - 1

VALUE OF FUNCTION

Aim :

- To construct an applet to establish geometrically the correspondance of a number and its image under a function.
- To use this applet to find the images of numbers under various functions.
- To use an applet to visualise the comparison of a function with an input - output machine.

Concepts

- Image of a number a under a function f is denoted by $f(a)$
- Graph of the function f is the collection of points $(a, f(a))$

> Activity 1.1 Function

Procedure :

- Draw the graph of $f(x) = x^2$
- Create a number slider a with increment 0.01
- Plot the points $A(a,0)$, $B(a, f(a))$, $C(0, f(a))$. (Give inputs like $A=(a,0)$)
- Draw the line segments AB and BC using **Segment tool**
- Show the coordinates of A, B and C.
- Now drag the point A along the x-axis (either click and drag the point or using slider - click and drag the slider point to change the value of a) and observe the movement of C on the y-axis

	$3^{1/3}$	$\sqrt{1.8}$	$2^{2/3}$	$\sqrt{\sqrt{5}}$	$(3.46)^{-3/2}$	$\sin 5$	$\log 4$	e^3
Function	$x^{1/3}$	$\sqrt{x}$	$x^{2/3}$	$\sqrt{x}$	$x^{-3/2}$	$\sin x$	$\log x$	e^x
Input (x)	3	1.8	2	$\sqrt{5}$	3.46	5	4	3
Value ($f(x)$)	1.442	1.342	1.587	1.495	0.155	0.959	0.602	20.086

Q) Using this, find the values of $(2\cdot3)^2, (-1\cdot8)^2, (0\cdot9)^2, (2\cdot9)^2$...

$(2\cdot3)^2 = 5\cdot29$, $(-1\cdot8)^2 = 3\cdot24$, $(0\cdot9)^2 = 0\cdot81$, $(2\cdot9)^2 = 8\cdot41$

> Activity 1.2 Values of Function

Procedure:

- Open the file Activity 1.1 and save as Activity 1.2
- Create an Input Box for f and change the function using it (Select Input Box tool → Click on Graphics View → give a suitable caption (say function) → Linked Object → $f(x) = x^2$ → OK)
- Similarly create an Input Box for the slider

Q) Change the function to $f(x) = \frac{1}{x}$, and observe how the point C moves as the point A approaches the origin from either side.

The point A approaches to 0 from the right of the origin. The point C tends to infinity and the point A approaches to 0 from the left of the origin the point C tends to $-\infty$

Q) Change the function to $f(x) = [x]$ and observe the movement of C according to A.

C moves from integer to integer. Reason range of the function = Z

> Activity 1.3 Function Machine

Procedure:

Use Applet ML 1.3

About the Applet

Three switches are provided on the machine.

- GREEN : Click to start the machine
- RED : Click to stop the machine
- BLUE : Click to reset.

Using Input Boxes we can change the function and the input number. The warning light provided on the machine turns red if the input number is out of the domain of the function.

Q) Change the function to $f(x) = \sqrt{x}$ and find the values of the following

i) $\sqrt{2}$ ii) $\sqrt{1.8}$ iii) $\sqrt{2/3}$

i) $\sqrt{2} = 1.41$, ii $\sqrt{1.8} = 1.34$ iii) $\sqrt{2/3} = 0.82$

Q) What happens if we give a -ve number as the input?

$f(x)$ is not defined. Because, domain is $[0, \infty)$

Q) Change the function to $f(x) = \frac{1}{x}$ and find the values of the following

i) $2/3$ ii) $-3/4$ iii) $\sqrt{2/3}$

i) $2/3 = 0.67$, ii) $-3/7 = -0.43$, iii) $\sqrt{2/3} = 0.82$

Q. What happens if the input is 0?

Input is 0, function is not defined. Because

domain = $R - \{0\}$

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LAB - 2
SHIFTING OF GRAPHS

Aim

To analyse the change in the graph of a function according to some slight changes in the definition

Concepts

- Graphs of a function

> **Activity 2.1 Shifting of graphs : $f(x)+a$**

Procedure:

- Draw the graph of $f(x) = x^2$
- Create a number slider 'a' with increment 0.1
- Draw the graph of $g(x) = f(x)+a$ (Input : $f+a$)

Q) Observe how the graph of $g(x)$ changes according to a.

The graph of $g(x)$ moves shifting vertically upward by a unit, if a is +ve $g(x)$ moves vertically downwards by a unit, if a is -ve.

- Create Input Boxes for editing function and slider 'a'.

Q) Do the above observations for different functions such as $|x|$, $[x]$, x^3 etc

Function	Domain	Range	Shifting
$\lvert x \rvert$	R	$[0,\infty)$	Vertical
$[x]$	R	Z	Vertical
x^3	R	R	Vertical
x^2	R	$[0,\infty)$	Vertical

The graph shift horizontally a unit towards left of the origin when a is +ve and toward right when a is -ve.

> Activity 2.2 Shifting of graphs : $f(x+a)$

Procedure:

- Open a new GeoGebra window.
- Draw the graph of $f(x) = x^2$
- Create a number slider 'a' with increment 0.1
- Draw the graph of $g(x) = f(x+a)$. (Input : $f(x+a)$)

Q) Observe how the graph of $g(x)$ changes according to 'a'

- Create Input Boxes for the function 'f' and slider 'a'

Q) Generalise the above observations with different functions such as $|x|$, $[x]$, x^3 etc.

- You may have use the animation option to change the slider
- Save this as Activity 2.2

> Activity 2.3 Reflection of a graph

Procedure:

- Open a new GeoGebra window.
- Draw the graph of $f(x) = x^2$
- Draw the graph of $g(x) = -f(x)$ (Input : $-f$)

Q) Compare the graph of $f(x)$ and $g(x)$

- Create an Input Box for f and change the function to

(i) x^2+2 (ii) x^2-1 (iii) $|x|-1$ (iv) $|x-1|$ (v) $[x]$ (vi) x^2+2x+1 (vii) $\frac{1}{x}$

Function	Domain	Range	Domain of $g(x)$	Range of $g(x)$
x^2+2	R	$[2,\infty)$	R	$(-\infty,-2]$
x^2-1	R	$[1,\infty)$	R	$(-\infty,1]$
$\lvert x\rvert-1$	R	$[-1,\infty)$	R	$(-\infty,1]$
$\lvert x-1\rvert$	R	$[0,\infty)$	R	$(-\infty,0]$
$[x]$	R	Z	R	$(-\infty,0]$
x^2+2x+1	R	$[0,\infty)$	R	Z
$\frac{1}{x}$	R			$(-\infty,0]$

$\frac{1}{x}$	R - {0}	R - {0}	R - {0}	R - {0}

$f(x)$ and $g(x)$ are reflection above x-axis.

> ## Activity 2.4 Reflection of a graph : $f(-x)$

Procedure :

- Open a new GeoGebra window
- Draw the graph of $f(x) = x^3$
- Draw the graph of $g(x) = f(-x)$ (Input : $f(-x)$)

Q) Compare the graph of $f(x)$ and $g(x)$

- Create an Input Box for f and change the function
  i) $1/x$ ii) $[x]$ iii) $|x|$ iv) x^2 v) $(x-2)^2$.

	Function	Domain	Range	Domain in $g(x)$	Range in $g(x)$
Odd function	$1/x$	R - {0}	R - {0}	R - {0}	R - {0}
Odd function	$[x]$	R	Z	R	Z
Even function	$\|x\|$	R	$[0, \infty)$	R	$[0, \infty)$
Even function	x^2	R	$[0, \infty)$	R	$[0, \infty)$
Neither odd nor even f^n	$(x-2)^2$	R	$[0, \infty)$	R	$[0, \infty)$

Q) What is the speciality of the graph of odd and even functions?
For even function, reflection is same.

Q) Identify odd and even functions discussed in this lab.
$|x|$ and x^2 are even function.
$1/x$ and $[x]$ are odd function.

Q) Is there any function which is neither odd nor even?
$(x-2)^2$

- ~~Save this file as Activity 2.4.~~

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