ISC Class 11 Mathematics Project

Topic: *Drawing Graphs of sinx, sin2x, 2sinx, and sinx/2on same graph using same coordinate axes and its interpretation*
Name:
Class: XI
School:
Session: 2025–2026

Preface

I am pleased to present this Mathematics project on the topic **“Drawing Graphs of sinx, sin2x, 2sinx, and sinx/2”** as a part of the ISC Class 11 curriculum. This project allowed me to explore the fascinating behavior of trigonometric functions and their graphical representations.

Beginning from the concept of the unit circle to understanding how sine functions vary with changes in amplitude and frequency, this project helped me visualize abstract mathematical ideas in a concrete and meaningful way. Plotting and analyzing all four sine graphs on the same coordinate system not only deepened my conceptual understanding but also improved my skills in interpretation and analysis.

I am thankful to my Mathematics teacher for providing guidance and to my school for giving me this opportunity to engage with such an enriching mathematical concept.

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1. Introduction

Trigonometric functions are fundamental tools used in understanding periodic behavior such as sound waves, light patterns, and electrical currents. The sine function is a basic periodic function that serves as the foundation for other trigonometric graphs.

This project focuses on comparing and analyzing the graphs of:

- sinx
- sin2x
- 2sinx
- sinx/2

We begin with the unit circle and define the sine function by marking the coordinates (cosx,sinx) on the circle. In the unit circle, the sine of an angle x represents the y-coordinate of the corresponding point, which is the perpendicular distance from the point (a,b) to the x-axis. Therefore, b=sinx.

Since the sine function takes all real values of x, and provides a unique output for each, it qualifies as a function. By plotting the sine values against the angle x (in radians) on a coordinate plane, we obtain the sine wave.

The shape of the sine wave can change depending on the transformation of the sine function. These changes may include horizontal shifts (left or right), vertical shifts (up or down), changes in frequency (the number of cycles in a given interval), and changes in amplitude (the height of the wave). Each transformation reflects a corresponding modification in the algebraic form of the sine function.

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2. Objective

To draw the graphs of:

- y = sinx
- y = sin2x
- y=2sinx
- y=sinx/2

...on the same coordinate axes over the interval $x \in [-2\pi, 4\pi]$, and to interpret how changes in amplitude and frequency affect the shape and nature of the sine function.

Note: **Frequency** is inversely proportional to the **period** of the sine function.

3. Theory

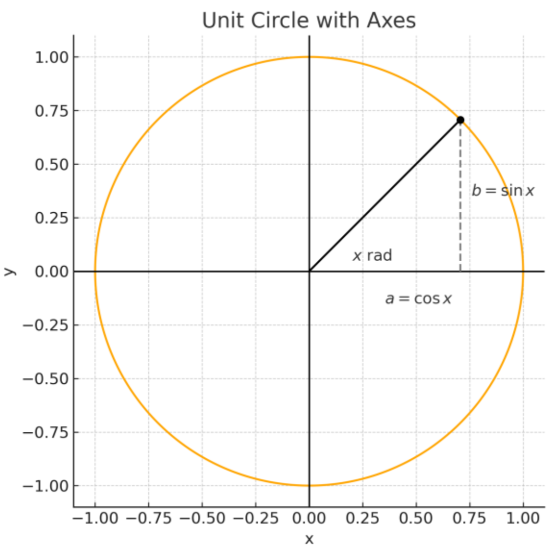
3.1 Visualization of Sinx on Unit Circle & on Coordinate plane

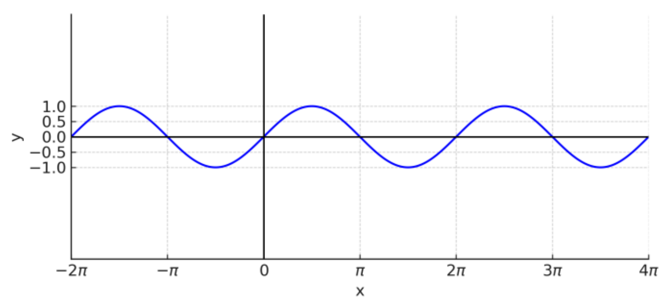
- **A unit circle** centered at the origin (0,0)

- Pick a point on the circle determined by an angle x (in radians), measured counterclockwise from the positive x-axis

- The **coordinates of the point** on the unit circle are (cosx,sinx)

- The **sine value** is the **vertical distance** from this point to the x-axis (i.e., the **y-coordinate**)





3.2 The general form of the sine function is: **y =Asin(Bx + C) + D** Where:

- **A** controls the **amplitude** (maximum height)
  - Upper Limit = D + A & Lower Limit = D − A
- **B** controls the **period**:

  Period=2π/B (As sinx is of period 2π)

- **C** determines the **phase shift** (horizontal translation):

  Shift=−C/B [If +ve than shift right & If –ve Shift left]

- **D** controls the **vertical shift [** If +ve than shift Up & If –ve Shift down]

4. Graphs of Trigonometric Functions

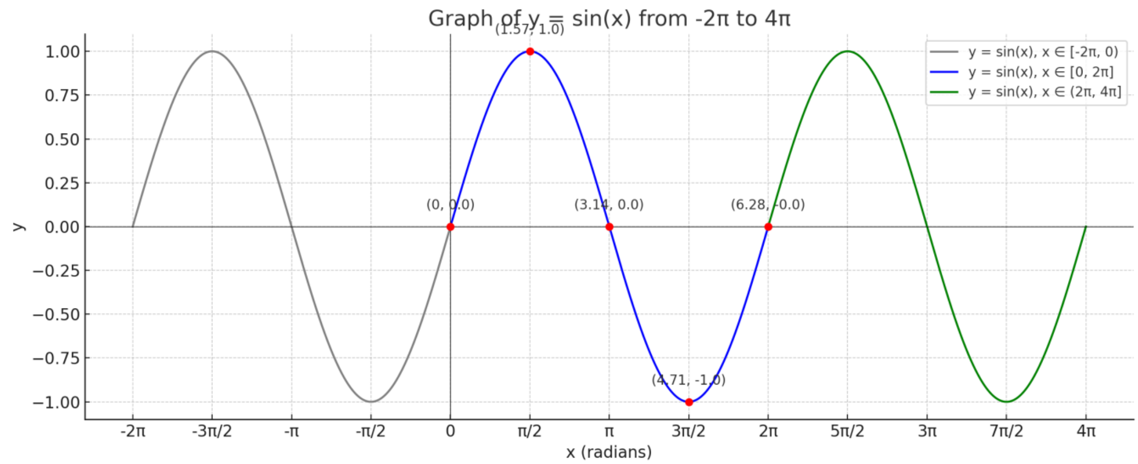
a) y = sinx

Compare with general form y=Asin(Bx+C) + D:

- A=1, B=1, C=0, D=0
- Amplitude: 1 → Upper limit = 1, Lower limit = -1
- Period: $2\pi/1 = 2\pi$
- Phase Shift: 0 Vertical Shift: 0

Conclusion:

This is the standard sine function. It passes through the origin and completes one full wave over $[0,2\pi]$.

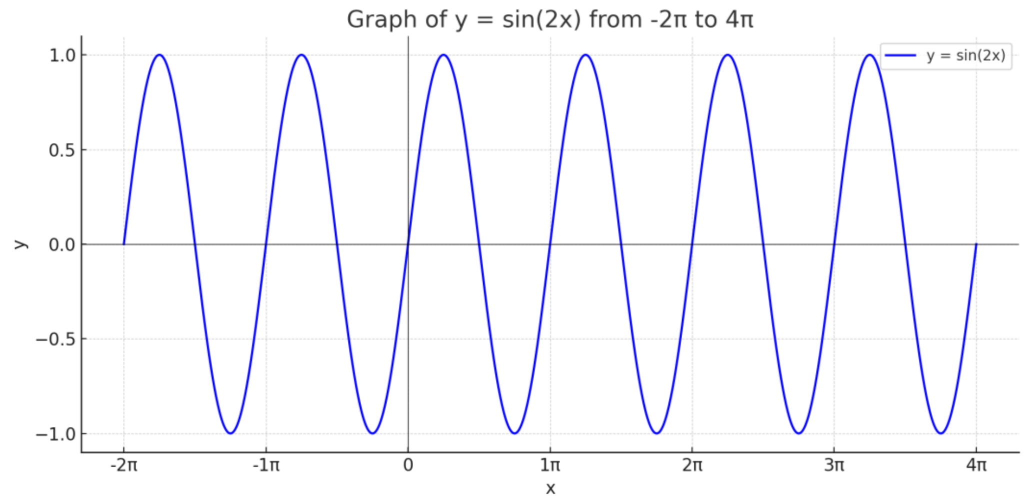


b) y = sin2x

Amplitude = 1 Period $2\pi/2 = \pi$

Phase Shift = 0 Vertical Shift = 0

This graph is horizontally compressed compared to y =

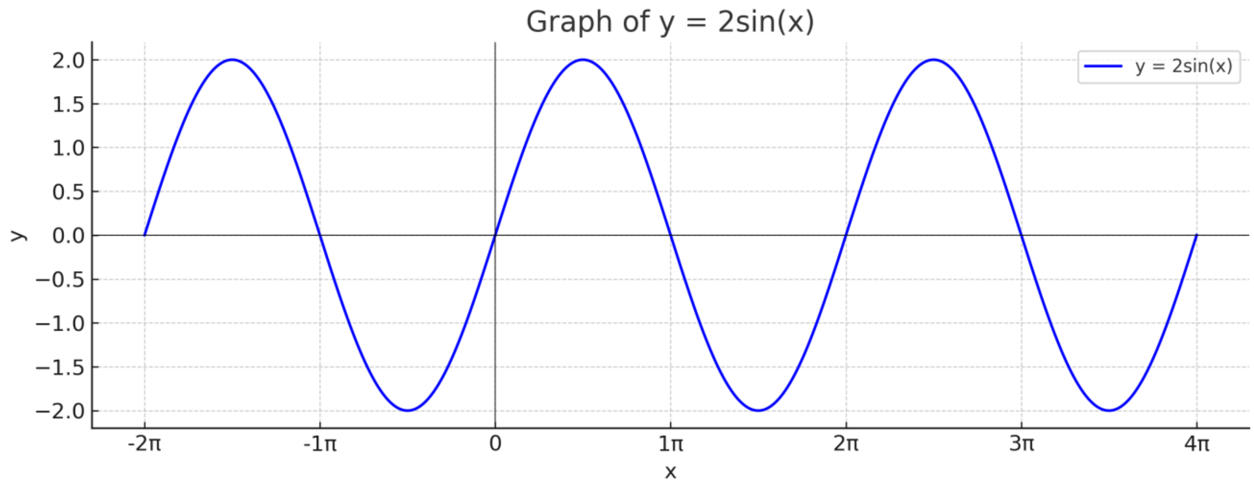


Conclusion

The graph of y = sin 2x completes two full cycles from 0 to 2π, indicating a doubled frequency. Its amplitude remains 1, but the wave is horizontally compressed compared to y = sin x.

c) y = 2sinx

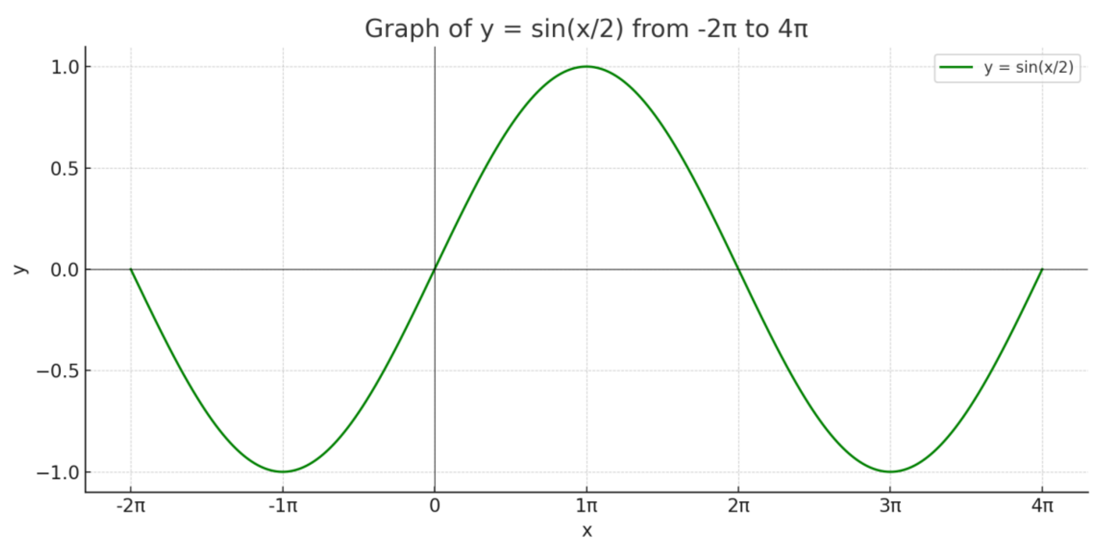
Amplitude = 2
Period = 2π/1 = 2π
Phase Shift = 0
Vertical Shift = 0



Conclusion: This graph is vertically stretched compared to y = sinx.

d) y = sinx/2

Amplitude = 1
Period = 4π
Phase Shift = 0
Vertical Shift = 0
This graph is horizontally stretched compared to y = sinx.



5. Combined Graph on Same Coordinate Axes

The combined graph includes:

Blue: sinx

Green: sin2x

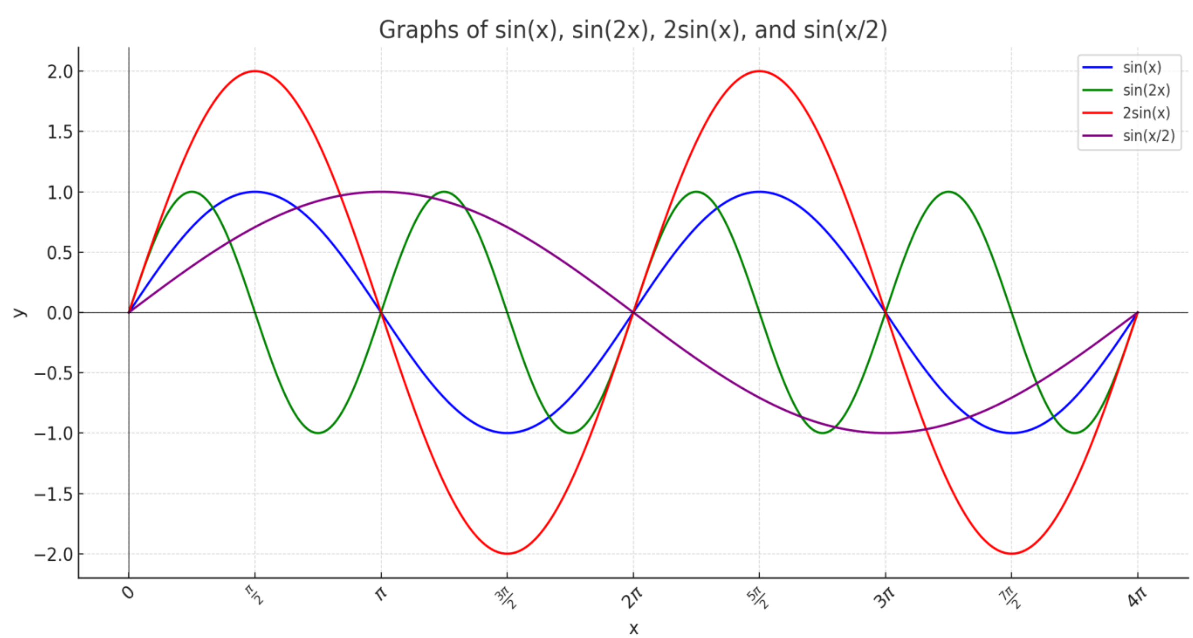
Red: 2sinx

Purple: sinx/2

All graphs are plotted over the interval $x \in [0,4\pi]$

Function	Amplitude	Period	Frequency	Description
y = sin(x)	1	2π\1 = 2π	1	Standard sine wave
y = sin(2x)	1	2π\2 = π	2	Oscillates faster
y = 2sin(x)	2	2π\2 = 2π	1	Taller wave
y = sin(x/2)	1	2π/1/2 = 4π	0.5	Slower oscillation

This comparison clearly visualizes the effects of frequency and amplitude on sine waves.



6. Interpretation and Analysis

- **sinx**: Standard wave with period 2π/1 =2π
- **sin2x**: Higher frequency → completes **2 cycles** in [0,2π]
- **2sinx**: Same period as sinx, but amplitude is doubled → peaks at +2 and -2
- **sinx/2**: Lower frequency → completes **only half a wave** in [0,2π] full wave in [0,4π]

These modifications represent real-life scenarios such as increasing pitch (frequency) in sound or increasing wave strength (amplitude) in electricity or water waves.

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7. Conclusion

This project enhanced understanding of trigonometric transformations. By analyzing graphs of modified sine functions, we observed the impact of changes in amplitude and frequency. This knowledge is foundational in fields like signal processing, physics, engineering, and computer graphics.

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8. Bibliography

- **ISC Mathematics Class XI** – M.L. Aggarwal
- **NCERT Mathematics Class XI Textbook**

Questions based on this project

1. What is the domain and range of the sine function?
2. Define the terms **amplitude**, **period**, **frequency**, **phase shift**, and **vertical shift** in the context of sine functions.
3. Why is the sine function called a **periodic function**?
4. Explain how the **unit circle** helps define the sine function.
5. What is the value of **sinx at x = 0, π/2, π, 3π/2, and 2π**?
6. How does the graph of **y = sin2x** differ from **y = sinx**?
7. Why does **y = 2sinx** have a taller wave than **y = sinx**?
8. What is the effect of multiplying x by a constant (like 2 or 1/2) inside the sine function?
9. Why is **y = sin2x** called a **horizontally compressed** graph?
10. Why is **y = sinx/2** considered **horizontally stretched**?
11. How many complete waves does **y = sin2x** complete in the interval [0, 2π]?
12. Between **y = sin2x** and **y = sinx/2**, which has the highest frequency, and why?
13. If we change the function to **y = sin(x − π/4)**, what type of transformation is it?
14. What happens to the graph if we add a vertical shift, say **y = sinx + 2**?
15. What challenges did you face while plotting all four graphs together?
16. What did you learn about **visualizing functions** through this project?
17. Which graph was easiest to interpret? Which was the most difficult, and why?
18. How did plotting the combined graph help you better understand transformations?
19. Can this understanding of graphs help in **Class 12 Calculus** or **Physics**?

Understanding graphs of sine functions is very helpful **in both** Class 12 Calculus **and** Physics**.**

In Calculus:

- Sine functions are commonly used in **differentiation and integration**.
- Knowing the graph helps visualize concepts like **maxima**, **minima**, **points of inflection**, and **rates of change**.
- Trigonometric functions appear in problems involving **limits**, **derivatives**, and **definite integrals**, especially in oscillatory motion and wave-related applications.

In Physics:

- Many physical phenomena, like **sound waves**, **light waves**, and **alternating current (AC)** electricity, follow **sine wave patterns**.
- Understanding amplitude and frequency helps in analyzing **simple harmonic motion (SHM)**, which is a key topic in Class 12 Physics.
- It also builds the foundation for topics such as **wave optics**, **electromagnetic waves**, and **quantum mechanics**, where sinusoidal behavior is common.