# MATHEMATICS LABORATORY ACTIVITY

Class X | CBSE Curriculum

**Chapter 2: Polynomials**

## 1. Topic

To verify geometrically the number of zeroes of a quadratic polynomial $p(x) = ax^2 + bx + c$ by drawing its graph and observing its intersection with the X-axis.

## 2. Objective

To understand that:

- A quadratic polynomial can have 0, 1, or 2 real zeroes.
- The zeroes of a polynomial $p(x)$ are the x-coordinates of the points where the graph of $y = p(x)$ intersects the X-axis.
- This can be verified by plotting the polynomial on graph paper and observing how many times the parabola crosses or touches the X-axis.

## 3. Pre-Requisite Knowledge

- Concept of a polynomial and degree of a polynomial.
- Meaning of zeroes of a polynomial: A zero of a polynomial $p(x)$ is a value of $x$ for which $p(x) = 0$.
- Standard form of a quadratic polynomial: $p(x) = ax^2 + bx + c$, where $a \neq 0$.
- Knowledge of the Cartesian coordinate system — X-axis, Y-axis, and plotting ordered pairs $(x, y)$.
- Concept of a parabola and how the direction (opening up/down) depends on the sign of 'a'.
- If $a > 0$, the parabola opens upward; if $a < 0$, the parabola opens downward.

## 4. Materials Required

- Graph paper (squared, 1 cm ruled)
- Sharp pencil, eraser, and ruler (30 cm scale)
- Coloured pens or sketch pens (red, blue, green) for drawing curves
- Geometry box (compass and set squares)
- Scientific calculator (optional, for verification)
- A thick cardboard or drawing board to fix the graph paper

## 5. Procedure

Follow the steps given below for each of the three cases:

### Case 1: $p(x) = x^2 + 2$ (Upward Parabola — No Real Zeroes)

**Step 1:** Prepare a table of values by substituting integer values of x from −4 to 4.

*x = −4, −3, −2, −1, 0, 1, 2, 3, 4*

*y = 18, 11, 6, 3, 2, 3, 6, 11, 18*

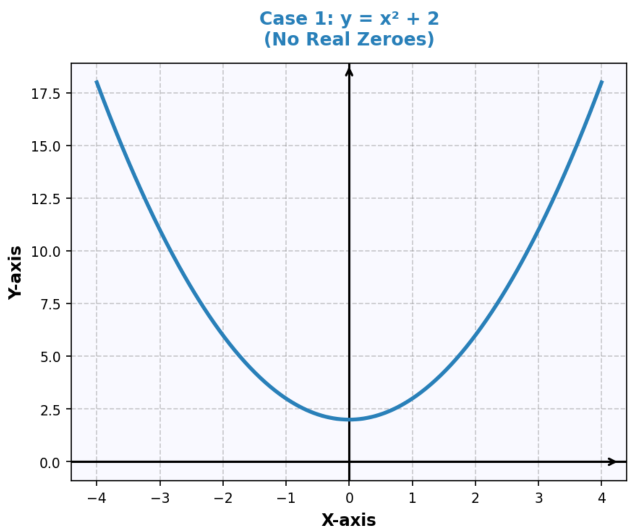
**Step 2:** Draw the X-axis and Y-axis on the graph paper. Choose a suitable scale (1 cm = 1 unit on X-axis; 1 cm = 2 units on Y-axis).

**Step 3:** Plot the ordered pairs (x, y) obtained in Step 1 on the graph paper.

**Step 4:** Join all the plotted points with a smooth free-hand curve (parabola) using a blue pen.

**Step 5:** Observe whether the parabola intersects the X-axis. The parabola lies entirely ABOVE the X-axis and does NOT cross it.

→ **Conclusion:** The parabola does not intersect the X-axis, hence $p(x) = x^2 + 2$ has NO real zeroes.




### Case 2: $p(x) = x^2$ (Upward Parabola — One Zero at Origin)

**Step 1:** Prepare a table of values:

*x = −4, −3, −2, −1, 0, 1, 2, 3, 4*

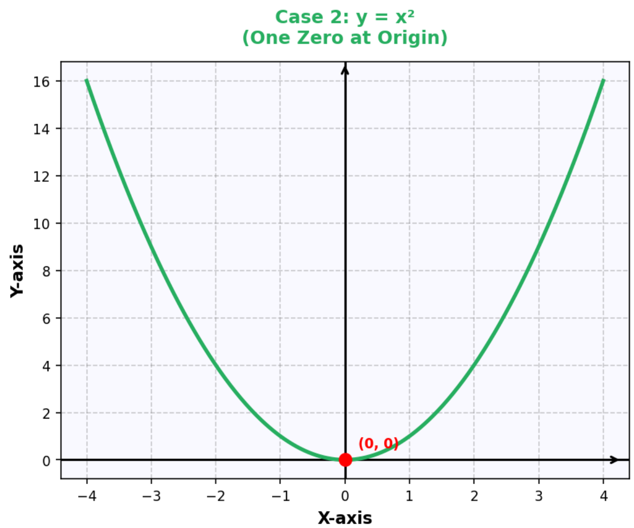
*y = 16, 9, 4, 1, 0, 1, 4, 9, 16*

**Step 2:** Draw the axes and choose a suitable scale (1 cm = 1 unit on X-axis; 1 cm = 2 units on Y-axis).

**Step 3:** Plot the points on graph paper and join them with a smooth curve using a green pen.

**Step 4:** Observe the parabola. It just TOUCHES the X-axis at the origin (0, 0) and does not cross it.

→ **Conclusion:** The parabola touches the X-axis at exactly one point (0, 0), so $x = 0$ is the only zero of $p(x) = x^2$.




### Case 3: $p(x) = -x^2 + 4$ (Downward Parabola — Two Distinct Zeroes)

**Step 1:** Prepare a table of values:

*x* = −4, −3, −2, −1, 0, 1, 2, 3, 4

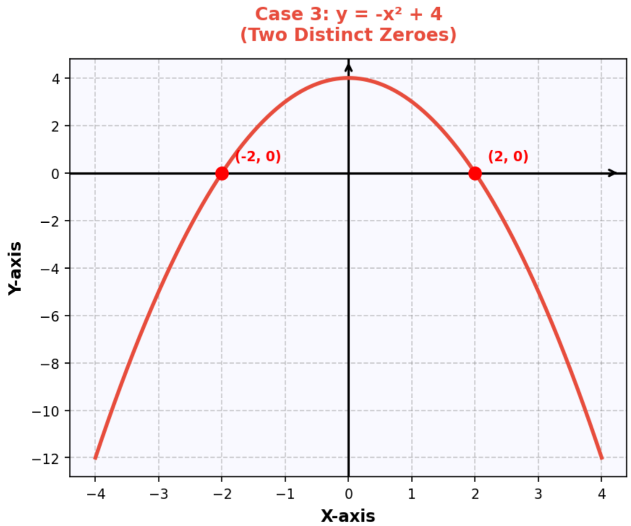
*y* = −12, −5, 0, 3, 4, 3, 0, −5, −12

**Step 2:** Draw the axes on graph paper. Choose scale: 1 cm = 1 unit on both axes.

**Step 3:** Plot all the ordered pairs and join them with a smooth downward-opening curve using a red pen.

**Step 4:** Mark the two points where the parabola crosses the X-axis: (−2, 0) and (2, 0) using a red dot.

→ **Conclusion:** The parabola cuts the X-axis at two distinct points (−2, 0) and (2, 0), so $x = -2$ and $x = 2$ are the two zeroes of $p(x) = -x^2 + 4$.




## 6. Observation

After plotting the three quadratic polynomials on graph paper, the following observations were made:

| Case | Polynomial | Nature of Parabola | Number of Zeroes | Co-ordinates of Zero(es) |
|---|---|---|---|---|
| Case 1 | $p(x) = x^2 + 2$ | Upward Parabola (No X-axis intersection) | 0 (No Zeroes) | None |
| Case 2 | $p(x) = x^2$ | Upward Parabola (Touches X-axis at origin) | 1 (One Zero) | (0, 0) |
| Case 3 | $p(x) = -x^2 + 4$ | Downward Parabola (Cuts X-axis at two pts) | 2 (Two Zeroes) | (-2, 0) and (2, 0) |

**Key Observations:**

- In Case 1, the parabola $y = x^2 + 2$ opens upward and its vertex is at (0, 2), which lies above the X-axis. It does not intersect the X-axis at any point. Hence, the polynomial has no real zeroes.
- In Case 2, the parabola $y = x^2$ opens upward and its vertex is exactly at the origin (0, 0), which lies ON the X-axis. It touches the X-axis at exactly one point. Hence, $x = 0$ is the only (repeated) zero.
- In Case 3, the parabola $y = -x^2 + 4$ opens downward (since $a = -1 < 0$). It cuts the X-axis at two distinct points: (−2, 0) and (2, 0). Hence, $x = -2$ and $x = 2$ are two distinct real zeroes.

## 7. Result

**It is verified geometrically that a quadratic polynomial $p(x) = ax^2 + bx + c$ can have:**

1. **NO real zeroes** — when the parabola does not intersect the X-axis at all (e.g., $p(x) = x^2 + 2$). This happens when the discriminant $b^2 - 4ac < 0$.
2. **EXACTLY ONE real zero** — when the parabola just touches the X-axis at one point (e.g., $p(x) = x^2$). This happens when the discriminant $b^2 - 4ac = 0$.
3. **TWO distinct real zeroes** — when the parabola cuts the X-axis at two different points (e.g., $p(x) = -x^2 + 4$). This happens when the discriminant $b^2 - 4ac > 0$.

**Thus, the number of zeroes of a quadratic polynomial is equal to the number of times its graph (parabola) intersects or touches the X-axis.**

**★★★ End of Activity ★★★**