

# MATHEMATICS

Teaching Mathematics at middle level is crucial as it lays the foundation of mathematical concepts at secondary level and beyond. The curriculum is well structured covering the core areas of arithmetic, algebra, geometry, commercial mathematics and statistics. Mathematics Education aims to develop capacities of logical thinking, finding patterns, explaining patterns, making and proving conjectures, problem solving, communicating clearly and precisely.

## **Curricular Goals & Competencies at Middle Level (Source : NCF 2023)**

- Represents and compares commonly used fractions in daily life (such as  $\frac{1}{2}$ ,  $\frac{1}{4}$ ) as parts of unit wholes, as locations on number lines and as divisions of whole numbers.
- Applies the four basic operations on whole numbers to solve daily life problems.
- Recognises, describes and extends simple number patterns such as odd numbers, even numbers, square numbers, cubes, powers of 2 and powers of 10.
- Recognises and creates symmetry (reflection, rotation) in familiar 2D and 3D shapes.
- Measures in non-standard and standard units and evaluates the need for standard units.
- Carries out simple unit conversions, such as from Centimeters to meters, within a system of measurements.
- Develops a sense for and an ability to manipulate (e.g. read, write, form, compare, estimate and apply operations).
- Learns about the inclusion of zero and negative quantities as numbers, and the arithmetic operations on them.
- Explores and applies fractions (both as ratios and in decimal form) in daily-life situations.
- Forms algebraic expressions using variables, coefficients and constants and manipulates them through basic operations.
- Outlines the properties of lines, angles, triangles, quadrilaterals and polygons and applies them to solve related problems.
- Draw and construct geometric shapes, such as lines, parallel lines, perpendicular lines, angles and simple triangles with specified properties using a compass.
- Understands congruence and similarity as it applies to geometric shapes and identifies similar and congruent triangles.

- Discovers, understands and uses formulae to determine the area of a square, triangle, parallelogram and trapezium and develops strategies to find the areas of composite 2D shapes.
- Understands equality between numerical expressions and learns to check arithmetical equations.
- Knows and appreciates the contributions of specific Indian Mathematician (such as Bandhayana, Pingala, Aryabhata, Brahmagupta, Virahanka, Bhaskara and Ramanujan).
- Extends the understanding of powers (radical powers) and exponents.
- Apply concepts from probability to solve problems on the likelihood of everyday events.
- Applies mathematical knowledge and tools to analyse problems/situations in multiple subjects across Science, Social Science, Visual Arts, Music, Vocational Education and Sports.
- Models daily-life phenomena and uses representations such as graphs, tables and equations to draw conclusions.
- Collects, organises and interprets the data using measures of central tendencies such as average/mean, mode and median.
- Selects, creates and uses appropriate graphical representations (e.g., pictographs, bar graphs, histograms, line graphs and pie charts) of data to make interpretations.

## **Examination**

### **General Instructions :**

- Examination at the end of the year will be from the entire syllabus and will be of 80 marks.
- Duration of the written exam will be 3 hours.
- Internal Assessment will be of 20 marks.

### **Detailed Syllabus and Learning Outcomes :**

#### **Chapter 1 : Square and Square Roots (14 Periods)**

Square of a number, triangular numbers and numbers between two consecutive square numbers, Square root of a number by the repeated subtraction method, prime factorization method and long division method and square roots of other numbers (not perfect squares) by estimation.

## Learning Outcomes :

Child

- Defines the square of a number.
- Identifies perfect squares of all types of numbers.
- Explains the concept of square root of numbers.
- Differentiates between square and square root of numbers.
- Appreciates facts about perfect squares.
- Finds the non-perfect square numbers between the square of the number  $n$  and  $(n + 1)$  where  $n$  is a natural number.
- Finds a Pythagorean triplet.
- Applies if  $a$  and  $b$  are perfect square ( $b \neq 0$ ) then

$$\sqrt{a \times b} = \sqrt{a} \times \sqrt{b}, \quad \sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$$

- Uses the fact that if  $p$  and  $q$  are not perfect squares, then to find  $\sqrt{\frac{p}{q}}$ , we express  $\frac{p}{q}$  as a decimal and then apply the division method.
- Applies repeated subtraction method, prime factorisation method, long division method and estimation method of finding square root of numbers.
- Finds square roots of rotational, decimal numbers up to and correct to three decimal places.

## Chapter 2 : Cubes and Cube Roots (6 Periods)

Cube of a number, Perfect cubes, Cube roots of perfect cubes by prime factorization (cube root should not exceed two digits), Cube root of a rational numbers and Cube root of a number through estimation. (only for perfect cubes)

## Learning Outcomes

Child

- Defines cube and perfect cube number.
- Identifies a perfect cube by prime factorization.
- Observes some interesting patterns of cubes.
- Applies properties of cubes and cube roots.
- Differentiates between cube and cube root of the numbers.

- Finds the cube roots of rational numbers.
- Calculates the cube roots of decimal numbers.
- Observes that the cube and cube root of negative numbers is negative.
- Applies the properties of cube roots.

$$1. \quad 3\sqrt{ab} = 3\sqrt{a} \times 3\sqrt{b} \qquad 2. \quad \sqrt[3]{\frac{a}{b}} = \frac{3\sqrt{a}}{3\sqrt{b}}$$

where a and b are integers and  $b \neq 0$ , to solve radical expressions.

- Estimates the cube roots of perfect cubes (estimation method).

### **Chapter 3 : Exponents and Radicals (8 Periods)**

Rational exponents, Laws of exponents including rational numbers as exponents, radicals and radicand.

#### **Learning Outcomes**

Child

- Defines Exponents and radicals.
- Identifies the relation between exponents and radicals.
- Applies the following laws of exponents.

If a, b > 0 are any two rational numbers and x, y are rational exponents, then

$$(i) \quad a^x \times a^y = a^{x+y}$$

$$(ii) \quad a^x \div a^y = a^{x-y}$$

$$(iii) \quad (a^x)^y = a^{xy}$$

$$(iv) \quad (a)^0 = 1$$

$$(v) \quad a^x \times b^x = (ab)^x$$

$$(vi) \quad \left(\frac{a}{b}\right)^x = \frac{a^x}{b^x}, b \neq 0$$

- Converts the rational exponent into radicals and vice versa.

### **Chapter 4 : Direct and Inverse Variations (10 Periods)**

Direct variation, Inverse variation, Time, Distance and work.

#### **Learning Outcomes**

Child

- Understands the meaning of variations at constant rate.
- Understands two types of variation : direct variation and inverse variation.

- Identifies the difference between two types of variation.
- Solves the problems based on two types of variation.
- Explains the relation between time, distance and work.
- Applies the concept of variation in time, distance and work.
- Understands the problems on the motion of trains.
- Calculates the speed of the train using variation.

## **Chapter 5 : Profit / Loss and Discount (12 Periods)**

Cost price, Selling price, Profit (or loss), Profit % (or loss %), word problems on profit and loss including discount (rebate), marked price, selling price (only single discount to be discussed G.S.T. (only for internal assessment through activity)

### **Learning Outcomes**

Child

- Explains the concept of cost price, selling price, profit and loss.
- Differentiates between the situation of loss percent and profit percent.
- Calculates profit percent and loss percent using the formulae.
- Observes the relation between MP, Discount and selling price.
- Applies the relation of MP, Discount and selling price while calculating profit / loss percent.
- Explains the concept of GST.
- Calculate GST while purchasing or selling any article.

## **Chapter 6 : Compound Interest (12 Periods)**

Simple interest, Compound interest, amount and compound interest by unitary method and by formula up to three years, Interest compounded annually, half yearly or quarterly up to three conversion periods and Growth and depreciation.

### **Learning Outcomes**

Child

- Defines and differentiates the terms S.I. and C.I.
- Derives the formula of compound interest by using a unitary method.

- Calculates Principal, Rate or Time when amount or compound interest is given.
- Calculates compound interest when interest is compounded annually, half yearly or quarterly.
- Applies the concept of growth and depreciation in daily life situations.

## Chapter 7 : Algebraic Identities (12 Periods)

Application of following identities :

- $(a + b)^2 = a^2 + 2ab + b^2$
- $(a - b)^2 = a^2 - 2ab + b^2$
- $(a + b)(a - b) = a^2 - b^2$
- Expansion of the square of a trinomial :  
 $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$
- Product of two binomials :  
 $(x + a)(x + b) = x^2 + (a + b)x + ab$
- Factorization of Algebraic Expressions based on above identities.

### Learning Outcomes

Child

- Differentiates between the algebraic expressions on the basis of the number of the terms.
- Explains the difference between an algebraic expression, equation and algebraic identity.
- Derives and applies the following identities :  
 $(a + b)^2 = a^2 + 2ab + b^2$   
 $(a - b)^2 = a^2 - 2ab + b^2$   
 $(a + b)(a - b) = a^2 - b^2$   
 $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$   
 Verifies the above identities geometrically.
- Factorises the algebraic expressions using above identities.
- Applies  $(x + a)(x + b) = x^2 + (a + b)x + ab$  for factorisation of algebraic expression.

## Chapter 8 : Polynomials

(8Periods)

Polynomial in one variable and its terms, polynomial in standard form, Coefficients and degree, Division of a monomial by a monomial, Division of a polynomial in one variable by a monomial or binomial (Restricted to polynomials in one variable of degree '4'), Division of a polynomial by a linear polynomial by factor method, Division of a polynomial by binomial by long division method, Verification by long division method (Dividend = Divisor  $\times$  Quotient + Remainder) and Concept of factor of a polynomial when the remainder is zero.

### Learning Outcomes

Child

- Distinguishes between monomial, binomial and trinomial.
- Defines polynomial.
- Differentiates between polynomial and algebraic expressions.
- Explains the importance of standard form and degree of the polynomial.
- Identifies the polynomial according to the degree.
- Divides a monomial by a monomial.
- Divides a polynomial by a monomial.
- Appreciates the factor method and long division method for dividing one polynomial by the other.
- Applies and appreciates division algorithms and the long division method for dividing the polynomials.

## Chapter 9 : Linear Equations in One Variable(10 periods)

Solving equations of the type  $\frac{ax + b}{cx + d} = k; cx + d \neq 0$

Word problems on linear equations in one variable.

Simple problems from daily life situations like age, coins, area and perimeter of rectangle, speed, distance, formation of '2' digit numbers etc. with special emphasis on ability to translate word problems into mathematical statements.

## Learning Outcomes

Child

- Identifies linear equations from a given collection of equations.
- Solves linear equations in one variable with rational number coefficients.
- Collects like terms.
- Expands the expressions using distributive property.
- Applies the concepts of cross multiplication in daily life situations.

### Chapter 10 : Parallel Lines

(10 Periods)

Definition, Angles made by a transversal with two parallel lines & their properties and the conditions for the lines to be parallel.

Verification and application of the following properties :

- Two lines parallel to the same line are parallel to each other.
- Two lines perpendicular to the same line are parallel to each other.

Division of a Line Segment : (Only for internal assessment through activity)

- To divide a line segment into a given number of equal segments.
- To divide a line segment in a given ratio internally. (constructions should be done by using ruler and compasses only).

## Learning Outcomes

Child

- Defines Parallel lines.
- Explains the varieties of angles made by any two (or more) lines intersected by the transversal.
- Differentiates between corresponding angles, alternate angles and co interior angles.
- Explains the condition for the corresponding angles to be equal.



- Observes the condition for the co interior angles to be supplementary.
- Understands the conditions for the lines to be parallel.
- Appreciates the properties of parallel and perpendicular lines.
- Divides the line segment in equal parts using ruler and compass by constructing parallel lines.
- Divides the line segment in the given ratio internally using ruler and compass by constructing parallel lines.

### **Chapter 11 : Understanding Quadrilaterals (12 Periods)**

Introduction to curves. Polygons (its types and properties), Quadrilaterals and its special types (trapezium, parallelogram, rectangle, rhombus & square) and Properties of special type of quadrilaterals.

Verification of the following properties :

- Opposite sides of a parallelogram are equal.
- Opposite angles of a parallelogram are equal.
- Diagonals of a parallelogram bisect each other.
- Diagonals of a rectangle are equal and bisect each other.
- Diagonals of a rhombus bisect each other at right angles.
- Diagonals of a square are equal, perpendicular to each other and bisect each other.

(Simple problems based on these properties involving one or two logical steps).

### **Learning Outcomes**

Child

- Defines curves, open curves, closed curves and polygons.
- Identifies different types of polygons on the bases of its sides.
- Differentiates between convex and concave polygons.
- Explains the properties of regular polygons.
- Explains the angle sum property of any polygon and observes its relation with the number of sides of the polygon.
- Uses the angle sum property of the exterior angles of any polygon.

- Identifies the types of polygons on the basis of their properties.
- Appreciates the properties of trapezium, parallelogram, rhombus, rectangle and square.
- Applies the properties of the above quadrilateral while finding the unknown sides or angles in different quadrilaterals.

## **Chapter 12 : Construction of Quadrilaterals (8 Periods)**

Construction of a quadrilateral with

- Four sides and one diagonal given
- Three sides and both diagonals given
- Two adjacent sides and three angles given
- Three sides and two included angles given

### **Learning Outcomes**

Child

- construct a quadrilateral as per the given following conditions :
  - when four sides and one diagonal are given.
  - when three sides and both diagonals given.
  - when two adjacent sides and three angles are given.
  - when three sides and two included angles are given.
- Constructs the quadrilateral (trapezium, parallelogram, rhombus, square and rectangle) by using its properties.

## **Chapter 13 : Introduction to Graphs (5 Periods)**

Cartesian plane. Plotting a point on the Cartesian plane, linear graph, independent and dependent variables, drawing of graphs and identification of figures formed.

### **Learning Outcomes**

Child

- Define Cartesian plane.
- Locates and marks points on the cartesian plane.
- Defines linear graphs.
- Distinguish between bar graph and linear graph.
- Observes and connects linear graphs to day to day life situations.
- Draws linear graphs with given data.
- Comprehends the information to create an equation in one variable, and then draw its linear graph.

## **Chapter 14 : Mensuration**

**(16 Periods)**

Area of trapezium, general quadrilateral and polygon, Surface area of cuboid, cube and right Circular cylinder, Volume of cuboid, cube and right circular cylinder.

Visualising solid shapes, polyhedron, Euler's formula and Mapping space around us. (by activities only)

### **Learning Outcomes**

Child

- Applies the concept of perimeter and area of a plane on two dimensional figures.
- Observes the difference between area and perimeter of a plane figure.
- Uses standard unit criteria as well as conversion of units according to given cost etc.
- Finds the area of trapezium by using its formulae.
- Finds the area of trapezium when the parallel sides and non-parallel sides are given.
- Calculates area of trapezium and quadrilateral when one diagonal and perpendicular distances from opposite vertices are given and area of irregular rectilinear figures.
- Appreciates the properties of three dimensional solids (cuboid, cube, cylinder etc.)
- Calculates surface area and volume of cuboid, cube and right circular cylinder.
- Demonstrates understanding of faces, vertices and edges of three solids.
- Applies and verifies Euler's formula.

## **Chapter 15 : Statistics & Probability**

**(14 Periods)**

Raw data, frequency, frequency table, Ungrouped and grouped data, Range, class size, class limits, class marks, Grouping the given data into class, Drawing, reading and interpretation of histogram, Circle graphs or pie chart and its drawing, probability, chance, Experiment, Outcome, Event, trial, probability of an event.

### **Learning Outcomes**

Child :

- Differentiate between raw data, ungrouped & grouped data.
- Explains the terms observation, raw data, range, frequency, frequency table, class size, class mark and class interval.
- Draw a histogram using the given data.

- Draw a pie-chart and interprets the same.
- Defines the term- trial, outcomes and probability.
- Finds the probability under different given situations.

## Chapter 16 : Rotational Symmetry

(By Activities only)

(4 Periods)

Rotational symmetry and its order, Centre of Rotation, Angle of Rotation, Line of symmetry, Rotational Symmetry.

### Learning Outcomes

Child

- Defines symmetry.
- Finds lines of symmetry of different figures.
- Defines rotational symmetry.
- Differentiates between symmetry and rotational symmetry.
- Observes the centre of rotation.
- Finds angle of rotation.
- Observes the order of rotation and lines of symmetry in regular polygon.
- Explains the relation between angle of rotation and order of rotation.
- Finds the order and angle of rotation in alphabets.

### Unit wise/Chapter wise Marks Distribution

S.No.	Units	Chapters	No. of Periods	Marks Allotted
1.	Number System	1. Squares and Square Roots 2. Cubes and Cube Roots 3. Exponents and Radicals	14 8 8	14
2.	Commercial Mathematics	4. Direct and Inverse Variations 5. Profit, Loss & Discount 6. Compound Interest	10 12 12	14
3.	Algebra	7. Algebraic Identities 8. Polynomials 9. Linear Equations in One Variable	12 10 12	16

4.	Geometry	10. Parallel Lines 11. Understanding Quadrilaterals 12. Construction of Quadrilaterals 16. Rotational Symmetry	10 14 10 4	14
5.	Graphs	13. Introduction to Graphs	6	5
6.	Mensuration	14. Mensuration	16	10
7.	Statistics & Probability	15. Statistics & Probability	14	7
				80

### Weightage as per Typology of Question

S.No.	Typology	No. of Questions	Marks Allotted	Total Marks
1.	MCQ+Assertion-Reason	MCQ – 18 Assertion-Reason – 2	1 mark each	1×20=20
2.	Case Study based	*VSA – 2 *SA-I – 1	4 marks each	4×3=12
3.	Short Answer type-1 (SA-1)	5	2 marks each	2×5=10
4.	Short Answer type-2 (SA-2)	6	3 marks each	3×6=18
5.	Long Answer	4	5 marks each	5×4=20
	Total	38	-	80

\*MCQ – Multiple Choice Question

\*VSA – Very Short Answer Type

\*SA-1 – Short Answer Type 1 (2 marks questions)

\*SA-2 – Short Answer Type 2 (3 marks questions)

**Note :** In case study based questions there is no MCQ.



## Assessing the Portfolio (Guidelines for Teachers)

- Completion of guided work focussed on specific curriculum objectives.
- Organisation of student's work.
- Evidence of improvement in student's work.
- Neatness and visual appeal.

**Note** : Evidence of Multiple Assessment & Subject Enrichment Activities also to be filed in Portfolio.

## Activity / Experiments / Projects

### (i) Suggested Mathematics Laboratory Activities (Minimum 2 activities must be taken)

1. Verify the Algebraic identity  $(a + b)^2 = a^2 + 2ab + b^2$  by paper cutting and pasting.
2. Identify various convex and concave polygons by paper folding.
3. Verify the relation between sector angles and number of spokes in a wheel and find the variation (direct / inverse) between them.
4. Verify that the sum of exterior angles of a polygon is  $360^\circ$  by paper cutting and pasting.
5. Verify that :
  - diagonals of a rectangle are of equal length.
  - diagonals of a square are of equal length.on a dotted paper using thread.
6. Draw the front view, top view and side view of three dimensional shapes made by combining unit cubes on an isometric sheet paper.
7. Verify that the difference between the squares of consecutive natural numbers is equal to their sum by paper cutting and pasting of squared sheets.

### Mandatory Mathematics Laboratory Activities

1. Make a cut outs of the following shapes and write down their order of rotation and angle of rotation :
  - Equilateral triangle
  - Rectangle
2. Collect and analyse receipts of different articles and verify the percentage of GST.
3. Divide a line segment in equal parts/in a given ratio internally (by using paper folding).
4. Make 3-D models of prisms and pyramids using their nets and verify Euler's formula for these solids.

### (ii) Project Work / Experiential Learning Activities

1. Life history of any Indian Mathematician and his/her contribution in the field of Mathematics (Project or PPT).

2. Number patterns (specially involving squares and cubes of numbers).
3. Do a survey of 20 people and collect the data screen time is more than 4 hours. Represent the collected data in the form of Histogram using paper cutting and pasting.
4. Draw a map of the route from your house to your school/ local market showing important landmarks
5. Make a mathematical e-magazine.

### **Multidisciplinary Project Idea**

**Title :** “Democracy in Action : The election experience”

**Objectives :** To engage students in a comprehensive multidisciplinary activity that explores the electoral process and its significance through various subjects.

Subjects involved :

- Social Studies (Civics)
- Science (Electoral inks)
- Language (Writing and Public Speaking)
- Art (Design a poster for campaigning)
- Technology (Digital media and presentation skills)
- Mathematics (Data Analysis)

### **Mathematics : Data Analysis of election (2024)**

**Aim :** To collect and tabulate the information (number of votes in thousands) secured by a party and represent it using a suitable statistical chart.

**Procedure :** Students will collect and tabulate the information in the table given below :

Name of the party	No. of voters (in Thousands)	% of votes	Sector angles
A			
B			
C			

### **Parameters of Assessment**

- Collection and organisation of data [The extent to which the data is gathered comprehensively and symmetrically. Are all relevant data points included? Is the data organised in a clear and logical manner?]
- Tabulation of data [How effectively the data is presented in a tabular format. Are the tables clear, concise, and appropriately labelled? Do they effectively summarise the data?]



- Data accuracy [Are there any errors or inconsistencies in the data?]
- Graphical representation [using a suitable statistical chart]
- Interpretation of data [clear understanding]

### **Interdisciplinary Activity**

Title : Thriving together : Embracing healthy habits for life.

Objective : To educate students on the key components of a healthy lifestyle.

Subjects involved :

- Science (Nutrition values)
- Mathematics (Conversion of units)
- Physical Education (Exercise and fitness)

Aim : To inculcate deep understanding of fundamental operations of mathematics, squares and square roots, measurements, conversions and graphs.

Procedure : Make your diet chart for a week. Calculate the nutrition intake and calories gained.

- Go for a walk daily for 45 minutes and count the no. of steps.
- Represent this information in the form of a linear graph.
- At the end of a week, check your height, weight and calculate BMI. Also calculate the BMI of your family members and plot on a graph.

### **Parameters of Assessment**

- Collection and organisation of data
- Tabulation of data
- Drawing of Linear graph
- Calculation of BMI
- Interpretation of data along with suggested remediation

### **Art Integration Activities (atleast one)**

Art Integration is a cross curricular pedagogical approach that utilises various aspects and forms of art and culture as the basis of learning of concepts across subjects. The purpose of art integration is to imbibe Indian ethos through integration of Indian art and culture in the teaching and learning process. The purpose is to strengthen the linkages between education and culture.

1. Jewellery designs of different states/tribes using maths shapes.
2. Exploring geometry behind Mandala Art.
3. Exploring Mathematics used in Warli Art.
4. Creating and analysing different Kolam/Rangoli patterns.

### **Prescribed Books**

Secondary Mathematics (DAV Publication)