

Secondary Education Curriculum

2076

Mathematics

Grades: 11 and 12

Subject code: Mat. 401 (Grade 11), Mat. 402 (Grade 12)

Credit hrs: 5

Working hrs: 160

1. Introduction

Mathematics is an indispensable in many fields. It is essential in the field of engineering, medicine, natural sciences, finance and other social sciences. The branch of mathematics concerned with application of mathematical knowledge to other fields and inspires new mathematical discoveries. The new discoveries in mathematics led to the development of entirely new mathematical disciplines. School mathematics is necessary as the backbone for higher study in different disciplines. Mathematics curriculum at secondary level is the extension of mathematics curriculum offered in lower grades (1 to 10).

This course of Mathematics is designed for grade 11 and 12 students as an optional subject as per the curriculum structure prescribed by the National Curriculum Framework, 2076. This course will be delivered using both the conceptual and theoretical inputs through demonstration and presentation, discussion, and group works as well as practical and project works in the real world context. Calculation strategies and problem solving skills will be an integral part of the delivery.

This course includes different contents like; Algebra, Trigonometry, Analytic Geometry, Vectors, Statistics and Probability, Calculus, Computational Methods and Mechanics or Mathematics for Economics and Finance.

Student's content knowledge in different sectors of mathematics with higher understanding is possible only with appropriate pedagogical skills of their teachers. So, classroom teaching must be based on student-centered approaches like project work, problem solving etc.

2. Level-wise Competencies

On completion of this course, students will have the following competencies:

1. use basic properties of elementary functions and their inverse including linear, quadratic, reciprocal, polynomial, rational, absolute value, exponential, logarithm, sine, cosine and tangent functions.
2. use principles of elementary logic to find the validity of statement and also acquire knowledge of matrix, sequence and series, and combinatory.
3. identify and derive equations or graphs for lines, circles, parabolas, ellipses, and hyperbolas, and identify the plane and its properties in space.
4. make connections and present the relationships between abstract algebraic structures with familiar number systems such as the integers, real numbers and complex numbers.
5. articulate personal values of statistics and probability in everyday life.
6. use vectors and mechanics in day to day life.

7. apply derivatives to determine the nature of the function and determine the maxima and minima of a function in daily life context.
8. explain anti-derivatives as an inverse process of derivative and use them in various situations.
9. apply numerical methods to solve algebraic equation and calculate definite integrals and use simplex method to solve linear programming problems (LPP).
10. use relative motion, Newton's laws of motion in solving related problems.
11. develop proficiency in application of mathematics in economics and finance.

3. Grade-wise Learning Outcomes

On completion of the course, the students will be able to:

S. N.	Content Domain/area	Learning Outcomes	
		Grade 11	Grade 12
1.	Algebra	1.1 acquaint with logical connectives and use them. 1.2 construct truth tables. 1.3 prove set identities. 1.4 state field axioms, order axioms of real numbers. 1.5 define interval and absolute value of real numbers. 1.6 interpret real numbers geometrically. 1.7 define domain and range of a function, inverse function composite function. 1.8 find domain and range of a function. 1.9 find inverse function of given invertible function. 1.10 calculate composite function of given functions. 1.11 define odd and even functions, periodicity of a function, monotonicity of a function. 1.12 sketch graphs of polynomial functions (eg: $\frac{a}{x}$, $\frac{x^2-a^2}{x-a}$, $\frac{a}{x+a}$, $ax^2 + bx + c$, ax^3), trigonometric, exponential, logarithmic	1.1 solve the problems related to permutation and combinations. 1.2 state and prove binomial theorems for positive integral index. 1.3 state binomial theorem for any index (without proof). 1.4 find the general term and binomial coefficient. 1.5 use binomial theorem in application to approximation. 1.6 define Euler's number. 1.7 Expand e^x , a^x and $\log(1+x)$ using binomial theorem. 1.8 define binary operation and apply binary operation on sets of integers. 1.9 state properties of binary operations. 1.10 define group, finite group, infinite group and abelian group. 1.11 prove the uniqueness of identity, uniqueness of inverse, cancellation law. 1.12 state and prove De Moivre's theorem.

		<p>functions.</p> <p>1.13 define sequence and series.</p> <p>1.14 classify sequences and series (arithmetic, geometric, harmonic).</p> <p>1.15 solve the problems related to arithmetic, geometric and harmonic sequences and series.</p> <p>1.16 establish relation among A.M, G. M and H.M.</p> <p>1.17 find the sum of infinite geometric series.</p> <p>1.18 obtain transpose of matrix and verify its properties.</p> <p>1.19 calculate minors, cofactors, adjoint, determinant and inverse of a square matrix.</p> <p>1.20 solve the problems using properties of determinants.</p> <p>1.21 define a complex number.</p> <p>1.22 solve the problems related to algebra of complex numbers.</p> <p>1.23 represent complex number geometrically.</p> <p>1.24 find conjugate and absolute value (modulus) of a complex numbers and verify their properties.</p> <p>1.25 find square root of a complex number.</p> <p>1.26 express complex number in polar form.</p>	<p>1.13 find the roots of a complex number by De Moivre's theorem.</p> <p>1.14 solve the problems using properties of cube roots of unity.</p> <p>1.15 apply Euler's formula.</p> <p>1.16 define polynomial function and polynomial equation.</p> <p>1.17 state and apply fundamental theorem of algebra (without proof).</p> <p>1.18 find roots of a quadratic equation.</p> <p>1.19 establish the relation between roots and coefficient of quadratic equation.</p> <p>1.20 form a quadratic equation with given roots.</p> <p>1.21 find the sum of finite natural numbers, sum of squares of first n-natural numbers, sum of cubes of first n-natural numbers by using principle of mathematical induction.</p> <p>1.22 solve system of linear equations by Cramer's rule and matrix method (row-equivalent and inverse) up to three variables.</p>
2.	Trigonometry	<p>2.1 solve the problems using properties of a triangle (sine law, cosine law, tangent law, projection laws, half angle laws).</p> <p>2.2 solve the triangle (simple cases)</p>	<p>2.1 define inverse circular functions.</p> <p>establish the relations on inverse circular functions.</p> <p>2.2 find the general solution of trigonometric equations</p>
3.	Analytic geometry	<p>3.1 find the length of perpendicular from a given point to a given</p>	<p>3.1 obtain standard equation of ellipse and hyperbola.</p>

		<p>line.</p> <p>3.2 find the equation of bisectors of the angles between two straight lines.</p> <p>3.3 write the condition of general equation of second degree in x and y to represent a pair of straight lines.</p> <p>3.4 find angle between pair of lines and bisectors of the angles between pair of lines given by homogenous second degree equation in x and y.</p> <p>3.5 solve the problems related to condition of tangency of a line at a point to the circle.</p> <p>3.6 find the equations of tangent and normal to a circle at given point.</p> <p>3.7 find the standard equation of parabola.</p> <p>3.8 find the equations of tangent and normal to a parabola at given point.</p>	<p>3.2 find direction ratios and direction cosines of a line.</p> <p>3.3 find the general equation of a plane.</p> <p>3.4 find equation of a plane in intercept and normal form.</p> <p>3.5 find the equation of plane through three given points.</p> <p>3.6 find the equation of geometric plane through the intersection of two given planes.</p> <p>3.7 find angle between two geometric planes.</p> <p>3.8 write the conditions of parallel and perpendicular planes.</p> <p>3.9 find the distance of a point from a plane.</p>
4.	Vectors	<p>4.1 identify collinear and non-collinear vectors; coplanar and non-coplanar vectors.</p> <p>4.2 write linear combination of vectors.</p> <p>4.3 find scalar product of two vectors.</p> <p>4.4 find angle between two vectors.</p> <p>4.5 interpret scalar product of vectors geometrically.</p> <p>4.6 apply properties of scalar product of vectors in trigonometry and geometry.</p>	<p>4.1 define vector product of two vectors, interpretation vector product geometrically.</p> <p>4.2 solve the problems using properties of vector product.</p> <p>4.3 apply vector product in geometry and trigonometry.</p>
5.	Statistics and Probability	<p>5.1 calculate the measures of dispersion (standard deviation).</p> <p>5.2 calculate variance, coefficient of variation and coefficient of skewness.</p> <p>5.3 define random experiment,</p>	<p>5.1 calculate correlation coefficient by Karl Pearson's method.</p> <p>5.2 calculate rank correlation coefficient by Spearman method.</p> <p>5.3 interpret correlation</p>

		<p>sample space, event, equally likely cases, mutually exclusive events, exhaustive cases, favorable cases, independent and dependent events.</p> <p>5.4 find the probability using two basic laws of probability.</p>	<p>coefficient.</p> <p>5.4 obtain regression line of y on x and x on y.</p> <p>5.5 solve the simple problems of probability using combinations.</p> <p>5.6 solve the problems related to conditional probability.</p> <p>5.7 use binomial distribution and calculate mean and standard deviation of binomial distribution.</p>
6.	Calculus	<p>6.1 define limits of a function.</p> <p>6.2 identify indeterminate forms.</p> <p>6.3 apply algebraic properties of limits.</p> <p>6.4 evaluate limits by using theorems on limits of algebraic, trigonometric, exponential and logarithmic functions.</p> <p>6.5 define and test continuity of a function.</p> <p>6.6 define and classify discontinuity.</p> <p>6.7 interpret derivatives geometrically.</p> <p>6.8 find the derivatives, derivative of a function by first principle (algebraic, trigonometric exponential and logarithmic functions).</p> <p>6.9 find the derivatives by using rules of differentiation (sum, difference, constant multiple, chain rule, product rule, quotient rule, power and general power rules).</p> <p>6.10 find the derivatives of parametric and implicit functions.</p> <p>6.11 calculate higher order derivatives.</p>	<p>6.1 find the derivatives of inverse trigonometric, exponential and logarithmic functions by definition.</p> <p>6.2 establish the relationship between continuity and differentiability.</p> <p>6.3 differentiate the hyperbolic function and inverse hyperbolic function</p> <p>6.4 evaluate the limits by L'hospital's rule (for $0/0$, ∞/∞).</p> <p>6.5 find the tangent and normal by using derivatives.</p> <p>6.6 interpret geometrically and verify Rolle's theorem and Mean Value theorem.</p> <p>6.7 find the anti-derivatives of standard integrals, integrals reducible to standard forms and rational function (using partial fractions also).</p> <p>6.8 solve the differential equation of first order and first degree by separable variables, homogenous, linear and exact differential equation.</p>

		6.12 check the monotonicity of a function using derivative. 6.13 find extreme values of a function. 6.14 find the concavity of function by using derivative. 6.15 define integration as reverse of differentiation. 6.16 evaluate the integral using basic integrals. 6.17 integrate by substitution and by integration by parts method. 6.18 evaluate the definite integral. 6.19 find area between two curves.	
7.	Computational methods	7.1 describe the basic characteristics of numerical computing (accuracy, rate of convergence, numerical stability and efficiency), solve algebraic equation and transcendental equation by bisection method and by Newton-Raphson method and find approximate error by these methods 7.2 integrate numerically by trapezoidal rule and Simpson's rule	7.1 solve the linear programming problems (LPP) by simplex method 7.2 solve the system of linear equations by Gauss Elimination method (up to 3 variables)
8.	Mechanics	8.1 find resultant forces by parallelogram of forces. 8.2 solve the problems related to composition and resolution of forces. 8.3 obtain resultant of coplanar forces/vectors acting on a point. 8.4 solve the forces/vectors related problems using triangle laws of forces and Lami's theorem. 8.5 solve the problems of motion of particle in a straight line, motion with uniform acceleration, motion under the gravity, motion in a smooth inclined plane.	8.1 find the resultant of like and unlike parallel forces/vectors. 8.2 solve the problems related to Newton's laws of motion and projectile. Or

	Or	Or	
		<p>Mathematics for Economics and Finance</p>	<p>8.1 interpret results in the context of original real- world problems.</p> <p>8.2 test how well it describes the original real- world problem and how well it describes past and/or with what accuracy it predicts future behavior.</p> <p>8.3 Model using demand and supply function.</p> <p>8.4 Find cost, revenue, and profit functions.</p> <p>8.5 Compute elasticity of demands.</p> <p>8.6 Construct mathematical models involving supply and income, budget and cost constraint.</p> <p>8.7 Test the equilibrium and break even condition.</p>
			<p>8.1 use quadratic functions in economics,</p> <p>8.2 understand input- output analysis and dynamics of market price.</p> <p>8.3 find difference equations.</p> <p>8.4 work with Cobweb model and lagged Keynesian macroeconomic model.</p> <p>8.5 explain mathematically equilibrium and break-even.</p> <p>8.6 construct mathematical models involving consumer and producer surplus.</p> <p>8.7 use quadratic functions in economics.</p> <p>8.8 do input- output analysis.</p> <p>8.9 analyze dynamics of market.</p> <p>8.10construct difference equations,</p> <p>8.11 understand cobweb model, lagged Keynesian macroeconomics model.</p>

4. Scope and Sequence of Contents

S.N.	Content area	Grade 11		Grade 12	
		Contents	Working hrs		Working hrs
1	Algebra	<p>1.1 Logic and Set: introduction of Logic, statements, logical connectives, truth tables, basic laws of logic, theorems based on set operations.</p> <p>1.2 Real numbers: field axioms, order axioms, interval, absolute value, geometric</p>	31	<p>1.1 Permutation and combination: Basic principle of counting, Permutation of (a) set of objects all different (b) set of objects not all different (c) circular arrangement (d) repeated use of the same objects, Combination of things all different, Properties of combination</p> <p>1.2 Binomial Theorem:</p>	31

		<p>representation of real numbers.</p> <p>1.3 Function: Review, domain & range of a function, Inverse function, composite function, functions of special type, algebraic (linear, quadratic & cubic), Trigonometric, exponential, logarithmic)</p> <p>1.4 Curve sketching: odd and even functions, periodicity of a function, symmetry (about origin, x-and y-axis), monotonicity of a function, sketching graphs of polynomials and some rational functions</p> <p>$\left(\frac{a}{x}, \frac{x^2-a^2}{x-a}, \frac{a}{x+a}, ax^2 + bx + c, ax^3\right)$, Trigonometric, exponential, logarithmic function (simple cases only)</p> <p>1.5 Sequence and series: arithmetic, geometric, harmonic sequences and series and their properties A.M, G.M, H.M and their relations, sum of infinite geometric series.</p> <p>1.6 Matrices and determinants: Transpose of a matrix and its properties, Minors and cofactors, Adjoint, Inverse matrix, Determinant,</p>		<p>Binomial theorem for a positive integral index, general term, Binomial coefficient, Binomial theorem for any index (without proof), application to approximation, Euler's number, Expansion of e^x, a^x and $\log(1+x)$ (without proof)</p> <p>1.3 Elementary Group Theory: Binary operation, Binary operation on sets of integers and their properties, Definition of a group, finite and infinite groups. Uniqueness of identity, Uniqueness of inverse, Cancellation law, Abelian group.</p> <p>1.4 Complex numbers: De Moivre's theorem and its application in finding the roots of a complex number, properties of cube roots of unity. Euler's formula.</p> <p>1.5 Quadratic equation: Nature and roots of a quadratic equation, Relation between roots and coefficient. Formation of a quadratic equation, Symmetric roots, one or both roots common.</p> <p>1.6 Sequence and series: Sum of finite natural numbers, sum of squares of first n-natural numbers, Sum of cubes of first n- natural numbers, principle of mathematical induction.</p> <p>1.7 Matrix based system of linear equation: Solution of a system of linear equations by Cramer's rule and matrix method (row- equivalent and inverse) up to three</p>	
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		<p>Properties of determinants (without proof)</p> <p>1.7 Complex number: definition imaginary unit, algebra of complex numbers, geometric representation, absolute value (Modulus) and conjugate of a complex numbers and their properties, square root of a complex number, polar form of complex numbers.</p>		variables.	
2	Trigonometry	<p>2.1 Properties of a triangle (Sine law, Cosine law, tangent law, Projection laws, Half angle laws).</p> <p>2.2 Solution of triangle (simple cases)</p>	8	<p>2.1 Inverse circular functions.</p> <p>2.2 Trigonometric equations and general values</p>	8
3	Analytic Geometry	<p>3.1 Straight Line: length of perpendicular from a given point to a given line, Bisectors of the angles between two straight lines.</p> <p>Pair of straight lines: General equation of second degree in x and y, condition for representing a pair of lines, Homogenous second-degree equation in x and y, angle between pair of lines, Bisectors of the angles between pair of lines.</p> <p>3.2 Circle: Condition of tangency of a line at a point to the circle, Tangent and normal to</p>	13	<p>3.1 Conic section: Standard equations of Ellipse and hyperbola.</p> <p>3.2 Coordinates in space: direction cosines and ratios of a line, general equation of a plane, equation of a plane in intercept and normal form, plane through 3 given points, plane through the intersection of two given planes, parallel and perpendicular planes, angle between two planes, distance of a point from a plane.</p>	13

		a circle. 3.3 Conic section: Standard equation of parabola, equations of tangent and normal to a parabola at a given point.			
4	Vectors	4.1 Vectors: collinear and non collinear vectors, coplanar and non-coplanar vectors, linear combination of vectors, 4.2 Product of vectors: scalar product of two vectors, angle between two vectors, geometric interpretation of scalar product, properties of scalar product, condition of perpendicularity, application of dot product in trigonometry and geometry.	7	4.1 Product of Vectors: vector product of two vectors, geometrical interpretation of vector product, properties of vector product, application of vector product in geometry and trigonometry.	7
5	Statistics & Probability	5.1 Measure of Dispersion: introduction, standard deviation, variance, coefficient of variation, Skewness (Karl Pearson and Bowley) 5.2 Probability: independent cases, mathematical and empirical definition of probability, two basic laws of probability(without proof).	9	5.1 Correlation and Regression: correlation, nature of correlation, correlation coefficient by Karl Pearson's method, interpretation of correlation coefficient, properties of correlation coefficient (without proof), rank correlation by Spearman, regression equation, regression line of y on x and x on y. 5.2 Probability: Dependent cases, conditional probability (without proof), binomial distribution, mean and standard deviation of binomial distribution	9

				(without proof).	
6	Calculus	<p>6.1 Limits and continuity: limits of a function, indeterminate forms. algebraic properties of limits (without proof), Basic theorems on limits of algebraic, trigonometric, exponential and logarithmic functions, continuity of a function, types of discontinuity, graphs of discontinuous function.</p> <p>6.2 Derivatives: derivative of a function, derivatives of algebraic, trigonometric, exponential and logarithmic functions by definition (simple forms), rules of differentiation. derivatives of parametric and implicit functions, higher order derivatives, geometric interpretation of derivative, monotonicity of a function, interval of monotonicity, extreme values of a function, concavity, points of inflection, derivative as rate of measure.</p> <p>6.3 Anti-derivatives: introduction, integration using basic integrals, integration by substitution and by parts methods, the</p>	31	<p>6.1 Derivatives: derivative of inverse trigonometric, exponential and logarithmic function by definition, relationship between continuity and differentiability, rules for differentiating hyperbolic function and inverse hyperbolic function, L'Hospital's rule ($0/0$, ∞/∞), differentials, tangent and normal, geometrical interpretation and application of Rolle's theorem and mean value theorem.</p> <p>6.2 Anti-derivatives: anti-derivatives of standard integrals, integrals reducible to standard forms, integrals of rational function.</p> <p>6.3 Differential equations: differential equation and its order, degree, differential equations of first order and first degree, differential equations with separable variables, homogenous, linear and exact differential equations.</p>	31

		definite integral, the definite integral as an area under the given curve, area between two curves.			
7	Computational Methods	<p>7.1 Numerical computation:</p> <ul style="list-style-type: none"> ▪ Characteristics of numerical computation (accuracy, rate of convergence, efficiency) ▪ Roots of algebraic and transcendental equation (bisection method and Newton-Raphson method) <p>7.2 Numerical integration: Trapezoidal rule and Simpson's 1/3 rule</p>	10	<p>7.1 Linear programming problems (LPP): simplex method (maximization problems only)</p> <p>7.2 System of linear equations: Gauss Elimination method</p>	10
8	<p>Mechanics Or</p> <p>Mathematics for Economics and</p>	<p>8.1 Statics: Forces and resultant forces, parallelogram law of forces, composition and resolution of forces, Resultant of coplanar forces acting on a point, Triangle law of forces and Lami's theorem.</p> <p>8.2 Dynamics: Motion of particle in a straight line, Motion with uniform acceleration, motion under the gravity, motion down a smooth inclined plane.</p> <p>8.3 Mathematics for economics and</p>	11	<p>8.1 Statics: Resultant of like and unlike parallel forces.</p> <p>8.2 Dynamics: Newton's laws of motion and projectile.</p> <p>8.3 Mathematics for economics and finance: Consumer and Producer Surplus, Quadratic functions in Economics, Input-Output analysis, Dynamics of market price, Difference equations, The Cobweb model, Lagged Keynesian macroeconomic model.</p>	11

	Finance	finance: Mathematical Models and Functions, Demand and supply, Cost, Revenue, and profit functions, Elasticity of demand, supply and income , Budget and Cost Constraints, Equilibrium and break even			
Total			120		120

5. Practical and project activities

The students are required to do different practical activities in different content areas and the teachers should plan in the same way. Total of 40 working hours is allocated for practical and project activities in each of the grades 11 and 12. The following table shows estimated working hours for practical activities in different content areas of grade 11 and 12

S. No.	Content area/domain	Working hrs in each of the grades 11 and 12
1.	Algebra	11
2.	Trigonometry	2
3.	Analytic geometry	5
4.	Vectors	3
5.	Statistics & Probability	3
6.	Calculus	11
7.	Computational methods	2
8.	Mechanics or Mathematics for Economics and Finance	3
Total		40

Here are some sample (examples) of practical and project activities.

Sample project works/mathematical activities for grade 11

1. Take a square of arbitrary measure assuming its area is one square unit. Divide it in to four equal parts and shade one of them. Again take one not shaded part of that square and shade one fourth of it. Repeat the same process continuously and find the area of the shaded region.
2. Write two simple statements related to mathematics and write four compound statements by using them.
3. Prepare a model to illustrate the values of sine function and cosine function for different angles which are multiples of $\frac{\pi}{2}$ and π .
4. Verify the sine law by taking particular triangle in four quadrants.
5. Prepare a concrete material to show parabola by using thread and nail in wooden panel.
6. Verify that the equation of a line passing through the point of intersection of two lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ is of the form $(a_1x + b_1y + c_1) + K(a_2x + b_2y + c_2) = 0$.
7. Prepare a model and verify that angle in a semi-circle is a right angle by using vector method.
8. Geometrically interpret the scalar product of two vectors.
9. Collect the scores of grade 10 students in mathematics and English from your school.
 - a. Make separate frequency distribution with class size 10.
 - b. Which subject has more uniform/consistent result?
 - c. Make the group report and present.
10. Roll two dices simultaneously 20 times and list all outcomes. Write the events that the sum of numbers on the top of both dice is a) even b) odd in all above list. Examine either they are mutually exclusive or not. Also find the probabilities of both events.
11. Find the area of circular region around your school using integration.
12. Take a metallic bar available at your surrounding and make a rectangular frame. Find the dimension of the rectangular metallic frame with maximum area.
13. Find the roots of any polynomial equation by using any ICT tools and present it in the classroom.
14. Investigate a daily life problem on projectile motion. Solve that problem and present in the classroom.
15. Construct mathematical models involving supply and income, budget and cost constraint of a production company.

Sample project works/mathematical activities for grade 12

1. Represent the binomial theorem of power 1, 2, and 3 separately by using concrete materials and generalize it with n dimension relating with Pascal's triangle.
2. Take four sets R, Q, Z, N and the binary operations +, −, ×. Test which binary operation forms group or not with R, Q, Z, N.

3. Prepare a model to explore the principal value of the function $\sin^{-1}x$ using a unit circle and present in the classroom.
4. Draw the graph of $\sin^{-1}x$, using the graph of $\sin x$ and demonstrate the concept of mirror reflection (about the line $y = x$).
5. Fix a point on the middle of the ceiling of your classroom. Find the distance between that point and four corners of the floor.
6. Construct an ellipse using a rectangle.
7. Express the area of triangle and parallelogram in terms of vector.
8. Verify geometrically that: $\vec{c} \times (\vec{a} + \vec{b}) = \vec{c} \times \vec{a} + \vec{c} \times \vec{b}$
9. Collect the grades obtained by 10 students of grade 11 in their final examination of English and Mathematics. Find the correlation coefficient between the grades of two subjects and analyze the result.
10. Find two regression equations by taking two set of data from your textbook. Find the point where the two regression equations intersect. Analyze the result and prepare a report.
11. Find, how many peoples will be there after 5 years in your districts by using the concept of differentiation.
12. Verify that the integration is the reverse process of differentiation with examples and curves.
13. Correlate the trapezoidal rule and Simpson rule of numerical integration with suitable example.
14. Identify different applications of Newton's law of motion and related cases in our daily life.
15. Construct and present Cobweb model and lagged Keynesian macroeconomic model .

6. Learning Facilitation Method and Process

Teacher has to emphasis on the active learning process and on the creative solution of the exercise included in the textbook rather than teacher centered method while teaching mathematics. Students need to be encouraged to use the skills and knowledge related to maths in their house, neighborhood, school and daily activities. Teacher has to analyze and diagnose the weakness of the students and create appropriate learning environment to solve mathematical problems in the process of teaching learning.

The emphasis should be given to use diverse methods and techniques for learning facilitation. However, the focus should be given to those method and techniques that promote students' active participation in the learning process. The following are some of the teaching methods that can be used to develop mathematical competencies of the students:

- Inductive and deductive method
- Problem solving method
- Case study
- Project work method

- Question answer and discussion method
- Discovery method/ use of ICT
- Co-operative learning

7. Student Assessment

Evaluation is an integral part of learning process. Both formative and summative evaluation system will be used to evaluate the learning of the students. Students should be evaluated to assess the learning achievements of the students. There are two basic purposes of evaluating students in Mathematics: first, to provide regular feedback to the students and bringing improvement in student learning-the formative purpose; and second, to identify student's learning levels for decision making.

a. Internal Examination/Assessment

- Project Work:** Each Student should do one project work from each of eight content areas and has to give a 15 minute presentation for each project work in classroom. These eight project works will be documented in a file and will be submitted at the time of final examination. Out of eight projects, any one should be presented at the time of final examination by each student.
- Mathematical activity:** Mathematical activities mean various activities in which students willingly and purposefully work on Mathematics. Mathematical activities can include various activities like (i) Hands-on activities (ii) Experimental activities (iii) physical activities. Each student should do one activity from each of eight content area (altogether eight activities). These activities will be documented in a file and will be submitted at the time of final examination. Out of eight activities, any one should be presented at the time of final examination by each student.
- Demonstration of Competency in classroom activity:** During teaching learning process in classroom, students demonstrate 11 competencies through activities. The evaluation of students' performance should be recorded by subject teacher on the following basis.
 - Through mathematical activities and presentation of project works.
 - Identifying basic and fundamental knowledge and skills.
 - Fostering students' ability to think and express with good perspectives and logically on matters of everyday life.
 - Finding pleasure in mathematical activities and appreciate the value of mathematical approaches.
 - Fostering and attitude to willingly make use of mathematics in their lives as well as in their learning.

- iv. **Marks from trimester examinations:** Marks from each trimester examination will be converted into full marks 3 and calculated total marks of two trimester in each grade.

The weightage for internal assessment are as follows:

Classroom participation	Project work/Mathematical activity	Demonstration of competency in classroom activity	Marks from terminal exams	Total
3	10	6	6	25

b. External Examination/Evaluation

External evaluation of the students will be based on the written examination at the end of each grade. It carries 75 percent of the total weightage. The types and number questions will be as per the test specification chart developed by the Curriculum Development Centre.