

Secondary Education Curriculum

2078

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) and is the foundation course for higher study.

This course of Mathematics is designed for grade 11 and 12 students who wish to choose as an alternative of Social Study and Life Skill education 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.

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

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 for lines, circles, parabolas, ellipses, and hyperbolas.
4. solve the problems related to real 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.

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 Be acquainted with logical connectives and construct truth tables. 1.2 Prove set identities. 1.3 Define interval and absolute value of real numbers. 1.4 Find domain and range of a function. 1.5 Find inverse function and calculate composite function of given functions. 1.6 Define odd and even functions, periodicity of a function, monotonicity of a function. 1.7 Sketch graphs of Quadratic, Cubic and rational functions of the form $\frac{1}{ax + b}$ where $a \neq 0$, Trigonometric (asinbx and acosbx), exponential (e^x), logarithmic function (lnx) 1.8 Define and classify sequence and series. 1.9 Solve the problems related to arithmetic, geometric and harmonic sequences and series. 1.10 Establish relation among A.M, G. M and H.M. 1.11 Find the sum of infinite geometric series . 1.12 Obtain transpose of matrix and verify its properties.	1.1 Solve the problems related to basic principle of counting. 1.2 Solve the problems related to permutation and combinations. 1.3 State and prove binomial theorems for positive integral index. 1.4 State binomial theorem for any integer. 1.5 Find the general term and binomial coefficient. 1.6 Use binomial theorem in application to approximation. 1.7 Define Euler's number. 1.8 Expand e^x , a^x and $\log(1+x)$ using binomial theorem. 1.9 Express complex number in polar form. 1.10 State and prove De Moivre's theorem. 1.11 Find the roots of a complex number by De Moivre's theorem. 1.12 Solve the problems using properties of cube roots of unity. 1.13 Apply Euler's formula. 1.14 Find the sum of finite natural numbers, sum of squares of first n-natural numbers, sum of cubes of first

		<p>1.13 Calculate minors, cofactors, adjoint, determinant and inverse of a square matrix.</p> <p>1.14 Solve the problems using properties of determinants.</p> <p>1.15 define polynomial function and polynomial equation.</p> <p>1.16 State and apply fundamental theorem of algebra.</p> <p>1.17 Find roots of a quadratic equation and establish the relation between roots and coefficient.</p> <p>1.18 Form a quadratic equation with given roots.</p> <p>1.19 Define a complex number and solve the problems related to algebra of complex numbers.</p> <p>1.20 Find conjugate and absolute (modulus) value of a complex numbers and verify their properties.</p> <p>1.21 Find square root of a complex number.</p>	<p>n-natural numbers.</p> <p>1.15 Find the sum of finite natural numbers, calculate sum of squares of first n-natural numbers, sum of cubes of first n-natural numbers by using mathematical induction.</p> <p>1.16 Solve system of linear equations by Cramer's rule and matrix methods (row-equivalent and inverse) up to three variables.</p>
2.	Trigonometry	<p>2.1 Define inverse trigonometric functions and establish the relations on inverse trigonometric functions.</p> <p>2.2 Find the general solution of trigonometric equations.</p>	<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>
3.	Analytic geometry	<p>3.1 Find the length of perpendicular from a given point to a given 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</p>	<p>3.1 Solve the problems related to condition of tangency of a line at a point to the circle.</p> <p>3.2 Find the equations of tangent and normal to a circle at given point.</p> <p>3.3 Find the standard equation of parabola.</p> <p>3.4 Find the equations of tangent and normal to a parabola at given point.</p>

		<p>and bisectors of the angles between pair of lines given by homogenous second degree equation in x and y</p> <p>3.5 Find the distance between two points in space, and direction cosines and ratios of a line.</p>	<p>3.5 Obtain standard equation of ellipse and hyperbola.</p>
4.	Vectors	<p>4.1 Identify collinear and non-collinear vectors</p> <p>4.2 Identify coplanar and non-coplanar vectors.</p> <p>4.3 Write linear combination of vectors.</p> <p>4.4 Identify linearly dependent and independent of vectors</p>	<p>4.1 Find scalar product of two vectors, angle between two vectors and interpret scalar product geometrically.</p> <p>4.2 Solve the problems using properties of scalar product</p> <p>4.3 Apply properties of scalar product of vectors in trigonometry and geometry.</p> <p>4.4 Define vector product of two vectors, and interpret vector product geometrically.</p> <p>4.5 Solve the problems using properties of vector product.</p> <p>4.6 Apply vector product in geometry and trigonometry.</p>
5.	Statistics and Probability	<p>5.1 Calculate standard deviation, variance and coefficient of variation</p> <p>5.3 Calculate coefficient of skewness by Karl Pearson method.</p> <p>5.4 Define random experiment, sample space, event, equally likely cases, mutually exclusive events, exhaustive cases, favorable cases, independent and dependent events.</p> <p>5.5 Find the probability using two basic laws of probability.</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 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>
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</p>	<p>6.1 Differentiate the hyperbolic function and inverse hyperbolic function</p> <p>6.2 Evaluate the limits by</p>

	<p>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 of a function by the first principle (algebraic, trigonometric, inverse 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>6.12 Check the monotonicity of a function using derivative.</p> <p>6.13 Find extreme values of a function.</p> <p>6.14 Find the concavity of function by using derivative.</p> <p>6.15 Define integration as reverse of differentiation.</p> <p>6.16 Evaluate the integral using basic integrals.</p> <p>6.17 Integrate by substitution and by parts method.</p> <p>6.18 Evaluate the definite integral.</p> <p>6.19 Find area between two</p>	<p>L'hospital's rule (for $\frac{0}{0}, \frac{\infty}{\infty}$).</p> <p>6.3 Find the tangent and normal by using derivatives.</p> <p>6.4 Find the derivative as rate of measure</p> <p>6.5 Find the anti-derivatives of standard integrals, integrals reducible to standard forms .</p> <p>6.6 Solve the differential equation of first order and first degree by separable variables, homogenous, linear and exact differential equation-</p>
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		curves.	
7.	Computational methods	7.1 Solve algebraic equation and transcendental equation by bisection method, 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 system of linear equations by Gauss Elimination method, Gauss Seidel Method (up to 3 variables) 7.2 Solve the linear programming problems (LPP) by simplex method
	Or Mechanics	7.1 Find resultant forces by parallelogram of forces. 7.2 Solve the problems related to composition and resolution of forces. 7.3 Obtain resultant of coplanar forces/vectors acting on a point. 7.4 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.	7.1 Solve the forces/vectors related problems using triangle laws of forces and Lami's theorem. 7.2 Solve the problems related to Newton's laws of motion and projectile.

4. Scope and Sequence of Contents

S.N.	Content area	Grade 11		Grade 12	
		Contents	Working hrs (Th. + Pr.)		Working hrs (Th. + Pr.)
1	Algebra	1.1 Logic and Set: Statements, logical connectives, truth tables, theorems based on set operations. 1.2 Real numbers: Geometric representation of real numbers, interval,	44	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,	44

		<p>absolute value.</p> <p>1.3 Function: Domain and range of a function, Inverse function, composite function, introduction of functions; algebraic (linear, quadratic & cubic), Transcendental (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 the graphs of Quadratic, Cubic and rational functions of the form $\frac{1}{ax + b}$ where $a \neq 0$, Trigonometric ($\sin bx$ and $\cos bx$), exponential (e^x), logarithmic function ($\ln x$)</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</p>		<p>Properties of combination</p> <p>1.2 Binomial Theorem: Binomial theorem for a positive integer, 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 Complex numbers: Polar form of 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>1.4 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 and use it to find sum.</p> <p>1.5 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 variables.</p>	
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		<p>matrix, Determinant, Properties of determinants (without proof)</p> <p>1.7 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>1.8 Complex number: Imaginary unit, algebra of complex numbers, geometric representation, absolute (Modulus) value and conjugate of a complex numbers and their properties, square root of a complex number.</p>			
2	Trigonometry	<p>2.1 Inverse circular functions.</p> <p>2.2 Trigonometric equations and general values</p>	12	<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>	12
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>3.2 Pair of straight lines: General equation of second degree in x and y, condition for representing a pair of lines, Homogenous</p>	20	<p>3.1 Conic section: Condition of tangency of a line at a point to the circle, Tangent and normal to a circle, Standard equation of parabola, equations of tangent and normal to a parabola at a given point, Standard equations of Ellipse and hyperbola.</p>	20

		<p>second-degree equation in x and y, angle between pair of lines, Bisectors of the angles between pair of lines</p> <p>3.3 Coordinates in space: Points in space, distance between two points, direction cosines and ratios of a line</p>			
4	Vectors	<p>4.1 Vectors: Collinear and non collinear vectors, coplanar and non-coplanar vectors, linear combination of vectors, Linearly dependent and independent</p>	12	<p>4.1 Product of Vectors: Scalar product of two vectors, angle between two vectors, geometric interpretation of scalar product, properties of scalar product, application of scalar product in geometry and trigonometry, vector product of two vectors, geometrical interpretation of vector product, properties of vector product, application of vector product in geometry and trigonometry.</p>	12
5	Statistics and Probability	<p>5.1 Measure of Dispersion: Standard deviation, variance, coefficient of variation, Skewness, Karl Pearson's coefficient of skewness</p> <p>5.2 Probability: Independent cases, mathematical and empirical definition of probability, two basic laws of probability (without proof).</p>	12	<p>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 (only elementary concept), regression equation, regression line of y on x and x on y.</p> <p>5.2 Probability: Dependent cases, conditional probability (without proof).</p>	12

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, inverse of 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.</p> <p>6.3 Anti-derivatives: Integration using basic integrals, integration by substitution and by parts methods, the definite integral, the</p>	48	<p>6.1 Derivatives: Rules for differentiating hyperbolic function and inverse hyperbolic function, L'Hospital's rule ($\frac{0}{0}, \frac{\infty}{\infty}$), differentials, tangent and normal, derivative as rate of measure.</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>	48
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		definite integral as an area under the given curve, area between two curves.			
7	Computational Methods	7.1 Numerical computation: Roots of algebraic and transcendental equation (bisection and Newton-Raphson method) 7.2 Numerical integration: Trapezoidal rule and Simpson's rule	12	7.1 System of linear equations: Gauss Elimination Method, Gauss Seidel Method 7.2 Linear programming problems (LPP): simplex method (two variables only)	12
	Or Mechanics	7.1 Statics: Forces and resultant forces, parallelogram law of forces, composition and resolution of forces, Resultant of coplanar forces acting on a point. 7.2 Dynamics: Motion of particle in a straight line, Motion with uniform acceleration, motion under the gravity, motion down a smooth inclined plane.		7.1 Statics: Triangle law of forces and Lami's theorem. 7.2 Dynamics: Newton's laws of motion and projectile.	
Total			160		160

**School must allocate separate classes for practical and project activities for students.*

5. Sample project works/practical works

Sample project works/practical works 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. Truth values of conjunction and disjunction using logic gate circuits

3. Write two simple statements related to mathematics and write four compound statements by using them.
4. 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 .
5. Prepare a model to explore the principal value of the function $\sin^{-1}x$ using a unit circle and present in the classroom.
6. Draw the graph of $\cos^{-1}x$, using the graph of $\cos x$ and demonstrate the concept of mirror reflection (about the line $y = x$).
7. Derive the length of perpendicular from (h, k) to line $ax+by+c=0$
8. Derive the condition that general equation of second degree x and y represent pair of line.
9. 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 $(a_1x + b_1y + c_1) + K(a_2x + b_2y + c_2) = 0$.
10. Prepare a model and verify that angle in a semi-circle is a right angle by using vector method.
11. 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.
12. 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.
13. Search the application of derivative in our daily life with example.
14. Find the area of circular region around your school using integration.
15. Take a metallic bar available at your surrounding and make a rectangular frame. Find the dimension of the rectangular metallic frame with maximum area.
16. Find the roots of any polynomial equation by using any ICT tools and present it in the classroom.
17. Correlate the trapezoidal rule and Simpson rule of numerical integration with suitable example.
18. Find the daily life problem related to motion of a particle in a straight line and solve that problem.

Sample project works/practical works 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. Verify the sine law by taking particular triangle in four quadrants.
3. Verifications of

- a) Cosine law
- b) Projection law
4. Construction of ellipse by using a piece of pencil, rope and nails
5. Prepare a concrete material to show parabola by using thread and nail in wooden panel.
6. Construct an ellipse using a rectangle.
7. Express the area of triangle and parallelogram in terms of vector.
8. 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.
9. 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.
10. Find how many peoples will be there after 5 years in your districts by using the concept of differentiation.
11. Verify that the integration is the reverse process of differentiation with examples and curves.
12. Identify different applications of Newton's law of motion and related cases in our daily life.
13. Investigate a daily life problem on projectile motion. Solve that problem and present in the classroom.
14. Write any one real life problem related to linear programming problem and solve that problem by using simplex method.

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 mathematics 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 evaluation

Internal assessment includes classroom participation, terminal examinations, and project work/practical work (computer works and lab work) and presentation. The scores of evaluation will be used for providing feedback and to improve their learning. Individual and group works are assigned as projects.

The basis of internal assessment is as follows:

Classroom participation	Marks from terminal examinations	project work/practical work	Total
3	6	16	25

(i) Classroom participation

The mark for classroom participation is 3 which is given on the basis of attendance and participation of students in activities in each grade.

(ii) Marks from trimester examinations

Marks from each trimester examination will be converted into full marks 3 and calculated total marks of two trimesters in each grade.

(iii) Project work/practical work

Each Student should do at least one project work/practical work from each of seven content areas and also be required to give a 15 minutes presentation for each project work and practical work in classroom. These seven project works/practical works will be documented in a file and will be submitted at the time of practical evaluation. Out of seven projects/practical works from each area any one project work/practical work should be presented at the time of practical evaluation by student.

b. Final/External Examination

Final/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.

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