

Secondary Education Curriculum

2076

Maths

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, 2075. 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. apply numerical methods to solve algebraic equation and calculate definite integrals and use simplex method to solve linear programming problems (LPP).
2. use principles of elementary logic to find the validity of statement.
3. make connections and present the relationships between abstract algebraic structures with familiar number systems such as the integers and real numbers.
4. use basic properties of elementary functions and their inverse including linear, quadratic, reciprocal, polynomial, rational, absolute value, exponential, logarithm, sine, cosine and tangent functions.
5. identify and derive equations or graphs for lines, circles, parabolas, ellipses, and hyperbolas,
6. use relative motion, Newton's laws of motion in solving related problems.

7. articulate personal values of statistics and probability in everyday life.
8. apply derivatives to determine the nature of the function and determine the maxima and minima of a function and normal increasing and decreasing function into context of daily life.
9. explain anti-derivatives as an inverse process of derivative and use them in various situations.
10. use vectors and mechanics in day to day life.
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 ordered pair, Cartesian product, domain and range of relation, inverse of relation and solve the related problems. 1.8 define domain and range of a function, inverse function composite function. 1.9 find domain and range of a function. 1.10 find inverse function of given invertible function. 1.11 calculate composite function of given functions. 1.12 define odd and even functions, periodicity of a function, monotonicity of a function. 1.13 sketch graphs of polynomial	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 ex , ax 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, cancelation law. 1.12 state and prove De Moivre's theorem.

		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 functions. 1.14 define sequence and series. 1.15 classify sequences and series (arithmetic, geometric, harmonic). 1.16 solve the problems related to arithmetic, geometric and harmonic sequences and series. 1.17 establish relation among A.M, G. M and H.M. 1.18 find the sum of infinite geometric series. 1.19 obtain transpose of matrix and verify its properties. 1.20 calculate minors, cofactors, adjoint, determinant and inverse of a square matrix. 1.21 solve the problems using properties of determinants. 1.22 define a complex number. 1.23 solve the problems related to algebra of complex numbers. 1.24 represent complex number geometrically. 1.25 find conjugate and absolute value (modulus) of a complex numbers and verify their properties. 1.26 find square root of a complex number. 1.27 express complex number in polar form.	1.13 find the roots of a complex number by De Moivre's theorem. 1.14 solve the problems using properties of cube roots of unity. 1.15 apply Euler's formula. 1.16 define polynomial function and polynomial equation. 1.17 state and apply fundamental theorem of algebra (without proof). 1.18 find roots of a quadratic equation. 1.19 establish the relation between roots and coefficient of quadratic equation. 1.20 form a quadratic equation with given roots. 1.21 sum of finite natural numbers, sum of squares of first n-natural numbers, sum of cubes of first n-natural numbers, intuition and induction, principle of mathematical induction. 1.22 using principle of mathematical induction, find the sum of finite natural numbers, sum of squares of first n-natural numbers, sum of cubes of first n-natural numbers. 1.23 solve system of linear equations by Cramer's rule and matrix method (row-equivalent and inverse) up to three variables.
2.	Trigonometry	2.1 solve the problems using properties of a triangle (sine law, cosine law, tangent law, projection laws, half angle laws).	2.1 define inverse circular functions. establish the relations on inverse circular functions.

		2.2 solve the triangle(simple cases)	2.2 find the general solution of trigonometric equations
3.	Analytic geometry	3.1 find the length of perpendicular from a given point to a given line. 3.2 find the equation of bisectors of the angles between two straight lines. 3.3 write the condition of general equation of second degree in x and y to represent a pair of straight lines. 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. 3.5 solve the problems related to condition of tangency of a line at a point to the circle. 3.6 find the equations of tangent and normal to a circle at given point. 3.7 find the standard equation of parabola. 3.8 find the equations of tangent and normal to a parabola at given point.	3.1 obtain standard equation of ellipse and hyperbola. 3.2 find direction ratios and direction cosines of a line. 3.3 find the general equation of a plane. 3.4 find equation of a plane in intercept and normal form. 3.5 find the equation of plane through three given points. 3.6 find the equation of geometric plane through the intersection of two given planes. 3.7 find angle between two geometric planes. 3.8 write the conditions of parallel and perpendicular planes. 3.9 find the distance of a point from a plane.
4.	Vectors	4.1 identify collinear and non-collinear vectors; coplanar and non-coplanar vectors. 4.2 write linear combination of vectors. 4.3 find scalar product of two vectors. 4.4 find angle between two vectors. 4.5 interpret scalar product of vectors geometrically. 4.6 apply properties of scalar product of vectors in trigonometry and geometry.	4.1 define vector product of two vectors, interpretation vector product geometrically. 4.2 solve the problems using properties of vector product. 4.3 apply vector product in plane trigonometry and geometry.
5.	Statistics and	5.1 calculate the measures of	5.1 calculate correlation coefficient

	Probability	dispersion (standard deviation). 5.2 calculate variance, coefficient of variation and coefficient of skewness. 5.3 define random experiment, sample space, event, equally likely cases, mutually exclusive events, exhaustive cases, favorable cases, independent and dependent events. 5.4 find the probability using two basic laws of probability.	by Karl Pearson's method. 5.2 calculate rank correlation coefficient by Spearman method. 5.3 interpret correlation coefficient. 5.4 obtain regression line of y on x and x on y. 5.5 solve the simple problems of probability using combinations. 5.6 solve the problems related to conditional probability. 5.7 use binomial distribution and calculate mean and standard deviation of binomial distribution.
6.	Calculus	6.1 define limits of a function. 6.2 identify indeterminate forms. 6.3 apply algebraic properties of limits. 6.4 evaluate limits by using theorems on limits of algebraic, trigonometric, exponential and logarithmic functions. 6.5 define and test continuity of a function. 6.6 define and classify discontinuity. 6.7 interpret derivatives geometrically. 6.8 find the derivatives, derivative of a function by first principle (algebraic, trigonometric exponential and logarithmic functions). 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).	6.1 find the derivatives of inverse trigonometric, exponential and logarithmic functions by definition. 6.2 establish the relationship between continuity and differentiability. 6.3 differentiate the hyperbolic function and inverse hyperbolic function 6.4 evaluate the limits by L'hospital's rule (for $0/0$, ∞/∞). 6.5 find the tangent and normal by using derivatives. 6.6 interpret geometrically and verify Rolle's theorem and Mean Value theorem. 6.7 find the anti-derivatives of standard integrals, integrals reducible to standard forms and rational function (using partial fractions also). 6.8 solve the differential equation of first order and first degree by separable variables, homogenous, linear and exact

		6.10 find the derivatives of parametric and implicit functions. 6.11 calculate higher order derivatives. 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.	differential equation.
7.	Computational methods	7.1 tell the basic idea of characteristics of numerical computing, accuracy, rate of convergence, numerical stability, efficiency). 7.2 approximate error in computing roots of non-linear equation. 7.3 solve algebraic polynomial and transcendental equations by bisection method	7.1 solve algebraic polynomial and transcendental equations by Newton-Raphson methods. 7.2 solve the linear programming problems (LPP) by simplex method of two variables. 7.3 integrate numerically by trapezoidal and Simpson's rules and estimate the errors.
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 Lami's theorem. 8.5 solve the problems of motion of particle in a straight line, motion with uniform acceleration,	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	motion under the gravity, motion in a smooth inclined plane.	
		Or	
	Mathematics for Economics and Finance	8.1 interpret results in the context of original real- world problems. 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. 8.3 Model using demand and supply function. 8.4 Find cost, revenue, and profit functions. 8.5 Compute elasticity of demands. 8.6 Construct mathematical models involving supply and income, budget and cost constraint. 8.7 Test the equilibrium and break even condition.	8.1 use quadratic functions in economics, 8.2 understand input- output analysis and dynamics of market price. 8.3 find difference equations. 8.4 work with Cobweb model and lagged Keynesian macroeconomic model. 8.5 explain mathematically equilibrium and break-even. 8.6 construct mathematical models involving consumer and producer surplus. 8.7 use quadratic functions in economics. 8.8 do input- output analysis. 8.9 analyze dynamics of market. 8.10construct difference equations, 8.11understand cobweb model, lagged Keynesian macroeconomics model.

4. Scope and Sequence of Contents

S.N.	Content area	Grade 11		Grade 12	
		Contents	Working hrs		Working hrs
1	Algebra	1.1 Logic and Set: introduction of Logic, statements, logical connectives, truth tables, basic laws of logic, theorems based on set operations. 1.2 Real numbers: field axioms, order	32	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	32

		axioms, interval, absolute value, geometric representation of real numbers. 1.3 Function: Review, domain & range of a function, Inverse function, composite function, functions of special type, algebraic (linear, quadratic & cubic), Trigonometric, exponential, logarithmic) 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 $\left(\frac{a}{x}, \frac{x^2-a^2}{x-a}, \frac{a}{x+a}, ax^2 + bx + c, ax^3\right)$, Trigonometric, exponential, logarithmic function (simple cases only) 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. 1.6 Matrices and determinants: Transpose of a matrix and its properties,		things all different, Properties of combination 1.2 Binomial Theorem: 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) 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. 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. 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. 1.6 Mathematical induction: Sum of finite natural numbers, sum of squares of first n-natural numbers, Sum of cubes of first n- natural numbers, Intuition and induction, principle of mathematical induction. 1.7 Matrix based system of linear equation: Consistency of system of linear equations, Solution of	
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		Minors and cofactors, Adjoint, Inverse matrix, Determinant of a square matrix, Properties of determinants (without proof) 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.		a system of linear equations by Cramer's rule. Matrix method (row- equivalent and Inverse) up to three variables.	
2	Trigonometry	2.1 Properties of a triangle (Sine law, Cosine law, tangent law, Projection laws, Half angle laws). 2.2 Solution of triangle (simple cases)	8	2.1 Inverse circular functions. 2.2 Trigonometric equations and general values	8
3	Analytic Geometry	3.1 Straight Line: length of perpendicular from a given point to a given line. Bisectors of the angles between two straight lines. 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	14	3.1 Conic section: Standard equations of Ellipse and hyperbola. 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.	14

		lines. 3.2 Circle: Condition of tangency of a line at a point to the circle, Tangent and normal to 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.	8	4.1 Product of Vectors: vector product of two vectors, geometrical interpretation of vector product, properties of vector product, application of vector product in plane trigonometry. 4.2 Scalar triple Product: introduction of scalar triple product	8
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).	10	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	10