INTERNATIONAL BACCALAUREATE (IB)
MATHEMATICAL STUDIES STANDARD LEVEL, YEARS 1 AND 2
Grades 11, 12

Unit of Credit: 1 Year for Year 1 and 1 Year for Year 2

Pre-requisite: Geometry for Year 1
IB Mathematical Studies Standard Level Year 1 for Year 2

Course Overview:
The Mathematical Studies Standard Level, Years 1 and 2 course syllabus focuses on important mathematical topics that are interconnected. The syllabus is organized and structured with the following tenets in mind: placing more emphasis on student understanding of fundamental concepts than on symbolic manipulation and complex manipulative skills; giving greater emphasis to developing students' mathematical reasoning rather than performing routine operations; solving mathematical problems embedded in a wide range of contexts; using the calculator effectively.

The course includes project work, a feature unique to mathematical studies SL within group 5. Each student completes a project, based on their own research; this is guided and supervised by the teacher. The project provides an opportunity for students to carry out a mathematical study of their choice using their own experience, knowledge and skills acquired during the course. This process allows students to take sole responsibility for a part of their studies in mathematics.

The students most likely to select this course are those whose main interests lie outside the field of mathematics, and for many students this course will be their final experience of being taught formal mathematics. All parts of the syllabus have therefore been carefully selected to ensure that an approach starting from first principles can be used. As a consequence, students can use their own inherent, logical thinking skills and do not need to rely on standard algorithms and remembered formulae. Students likely to need mathematics for the achievement of further qualifications should be advised to consider an alternative mathematics course.

Owing to the nature of mathematical studies SL, teachers may find that traditional methods of teaching are inappropriate and that less formal, shared learning techniques can be more stimulating and rewarding for students. Lessons that use an inquiry-based approach, starting with practical investigations where possible, followed by analysis of results, leading to the understanding of a mathematical principle and its formulation into mathematical language, are often most successful in engaging the interest of students. Furthermore, this type of approach is likely to assist students in their understanding of mathematics by providing a meaningful context and by leading them to understand more fully how to structure their work for the project.

Aims
1. To know and use essential notation, terminology, concepts and principles.
2. To organize, interpret and present information accurately in written, symbolic, tabular, graphical and diagrammatic forms.

3. To present and communicate information processed and analyzed by appropriate mathematical tools.
4. To recognize patterns and structures in a variety of situations and draw inductive generalizations.
5. To demonstrate knowledge of the applications of mathematics to life in a technological society.

Topic 1—Number and Algebra

The aims of this topic are to introduce some basic elements and concepts of mathematics, and to link these to financial and other applications.

- Natural numbers; integers; rational numbers; and real numbers.
- Not required: proof of irrationality, for example, of $\sqrt{2}$.
- Approximation: decimal places, significant figures.
- Percentage errors.
- Estimation.
- Expressing numbers in the form $a \times 10^k$, where $1 \leq a < 10$ and k is an integer.
- Operations with numbers in this form.
- I (Système International) and other basic units of measurement: for example, kilogram (kg), metre (m), second (s), litre (l), metre per second (m s^{-1}), Celsius scale.
- Currency conversions.
- Use of a GDC to solve
    - pairs of linear equations in two variables
    - quadratic equations.
- Arithmetic sequences and series, and their applications.
- Use of the formulae for the nth term and the sum of the first n terms of the sequence.
- Geometric sequences and series.
- Use of the formulae for the nth term and the sum of the first n terms of the sequence.
- Not required:
- formal proofs of formulae.
- Not required:
- use of logarithms to find n, given the sum of the first n terms; sums to infinity.
- Financial applications of geometric sequences and series:
    - compound interest
    - annual depreciation.
- Not required:
    - use of logarithms.

Topic 2—Descriptive Statistics

The aim of this topic is to develop techniques to describe and interpret sets of data, in preparation for further statistical applications.

- Classification of data as discrete or continuous.
- Simple discrete data: frequency tables.
- Grouped discrete or continuous data: frequency tables; mid-interval values; upper and lower boundaries.
- Frequency histograms.

- Cumulative frequency tables for grouped discrete data and for grouped continuous data; cumulative frequency curves, median and quartiles.
- Box-and whisker diagram - .
- Not required:
    - treatment of outliers.
- Measures of central tendency.
- For simple discrete data: mean; median; mode.
- For grouped discrete and continuous data: estimate of a mean; modal class.
- Measures of dispersion: range, interquartile range, and standard deviation.

Topic 3—Logic, Sets, and Probability

The aims of this topic are to introduce the principles of logic, to use set theory to introduce probability, and to determine the likelihood of random events using a variety of techniques.

- Basic concepts of symbolic logic: definition of a proposition; symbolic notation of propositions.
- Compound statements: implication, $\Rightarrow$; equivalence, $\Leftrightarrow$; negation, $\neg$; conjunction, $\wedge$; disjunction, $\vee$; exclusive disjunction, $\underline{\vee}$.
- Translation between verbal statements and symbolic form.
- Truth tables: concepts of logical contradiction and tautology.
- Converse, inverse, contrapositive.
- Logical equivalence.
- Testing the validity of simple arguments through the use of truth tables.
- Basic concepts of set theory: elements $x \in A$, subsets $A \subset B$; intersection $A \cap B$; union $A \cup B$; complement A' .
- Venn diagrams and simple applications.
- Not required:
    - knowledge of de Morgan's laws.
- Sample space; event A; complementary event, A' .
- Probability of an event.
- Probability of a complementary event.
- Expected value.
- Probability of combined events, mutually exclusive events, independent events.
- Use of tree diagrams, Venn diagrams, sample space diagrams and tables of outcomes.
- Probability using "with replacement" and "without replacement".
- Conditional probability.

Topic 4—Statistical Applications

The aims of this topic are to develop techniques in inferential statistics in order to analyze sets of data, draw conclusions and interpret these.

- The normal distribution.
- The concept of a random variable; of the parameters μ and σ ; of the bell shape; the symmetry about $x = \mu$.
- Diagrammatic representation.

- Normal probability calculations.
- Expected value.
- Inverse normal calculations.
- Not required:
    - Transformation of any normal variable to the standardized normal.
- Bivariate data: the concept of correlation.
- Scatter diagrams; line of best fit, by eye, passing through the mean point.

Year One

Introduction to the Graphical Display Calculator

- Arithmetic calculations
- Graphing functions
- Common buttons
- Data lists

Number and Algebra

- Sets of numbers; natural, integers, rational and real
- Approximation, decimal places, significant figures, percentage error, estimation
- Operations with scientific notation
- Metric system
- Arithmetic sequences and series
- Geometric sequences and series
- Solution of linear equations with GDC
- Solutions of quadratic equations by factorization and GDC

Functions

- Concepts of functions as a mapping, domain, range, mapping diagrams
- Linear functions and their graphs
- Quadratic functions, axis of symmetry, vertex, intercepts

Sets, Logic and Probability

- Basic concepts of set theory; subsets, intersection, union, complement
- Venn diagrams and simple applications
- Sample space and complementary events
- Equally likely events, probability of an event A given by $P(A) = \frac{n(A)}{n(U)}$ probability of a complementary event.
- Venn diagrams, tree diagrams, table of outcomes
- Laws of probability, combined events, mutually exclusive events, independent events, conditional probability

Geometry and Trigonometry

- Coordinates in two dimensions, points, lines, planes, distance formula
- Equations of line in two dimensions, gradient, intercepts parallel and perpendicular lines

- Right-angle trigonometry, trigonometric ratios
- Sine Rules, cosine rule, area of triangle, constructions
- Three dimensional geometry, cubes, prisms, pyramids, cylinders, spheres, cones

Statistics

- Classification of data as discrete or continuous
- Frequency tables and polygons
- Histograms stem and leaf diagrams, boundaries
- Cumulative frequency tables and graphs, box and whisker plots, percentiles, quartiles
- Measures of central tendency, mean, median, mode
- Measures of dispersion, range, interquartile range, standard deviation

Financial Mathematics

- Currency conversions
- Simple interest
- Compound interest, depreciation
- Construction and use of tables, loan and repayment schemes, investment and saving schemes, inflation

Year Two

Sets, Logic and Probability (continued)

- Concepts of symbolic logic, definition of proposition, notation
- Truth tables
- Definition of implication, converse, inverse and contrapositive
- Functions (continued)
- Exponential functions, growth and decay, asymptotic behavior
- Sine and cosine functions, amplitude, period
- Accurate graph drawing
- Use of GDC to sketch and analyze new functions.□ Statistics (continued)
- Scatter plots, line of best fit, bivariate data, Pearson's product-moment correlation coefficient, interpretation of correlations
- The regression line for y on x, use of regression line for predictions
- The Chi-Square test for independence, formulation of null and alternative hypothesis, significance levels, contingency tables, expected frequencies, degrees of freedom

Differential Calculus

- Gradient of two points on the graph of a function, behavior of the gradient as one point approaches other, tangent to a curve
- Derivatives of 1-variable monomials and polynomials
- Gradients of curves for given values of x, values of x where f '(x) is given, equations of the tangent at a given point
- Increasing and decreasing functions, graphical interpretation of derivatives
- Values of x where the gradient is zero, local maxima and minima

Project

- This is a significant piece of written work for which the student undertakes personal research on a mathematical project of their choice. This project, which is undertaken in the first semester of the second year, contributes the internal part of their IB math assessment.

Syllabus Review and Exam Preparation

- At the conclusion of the course in the final semester of the second year, students undertake a comprehensive review of the course material alongside preparation and practice for examinations.