Maths Studies SL has an emphasis on applications of mathematics, and the largest section is on statistical techniques. It is designed for students with varied mathematical backgrounds and abilities. It offers you opportunities to learn important concepts and techniques and to gain an understanding of a wide variety of mathematical topics. It prepares you to be able to solve problems in a variety of settings, to develop more sophisticated mathematical reasoning and to enhance their critical thinking. The individual project is an extended piece of work based on personal research involving the collection, analysis and evaluation of data. By taking this course you will be well prepared for a career in social sciences, humanities, languages or arts. You may need to utilize the statistics and logical reasoning that you have learned as part of the mathematical studies SL course in your future studies.

The 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 prior learning topics for the DP courses have been written in conjunction with the Middle Years Programme (MYP) mathematics guide. The approaches to teaching and learning for DP mathematics build on the approaches used in the MYP. These include investigations, exploration and a variety of different assessment tools.

Aims

The aims of all mathematics courses are to enable students to:

1. Enjoy mathematics, and develop an appreciation of the elegance and power of mathematics
2. Develop an understanding of the principles and nature of mathematics
3. Communicate clearly and confidently in a variety of contexts
4. Develop logical, critical and creative thinking, and patience and persistence in problem-solving
5. Employ and refine their powers of abstraction and generalization
6. Apply and transfer skills to alternative situations, to other areas of knowledge and to future developments
7. Appreciate how developments in technology and mathematics have influenced each other
8. Appreciate the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics
9. Appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives

10. Appreciate the contribution of mathematics to other disciplines, and as a particular “area of knowledge” in the TOK course.

Objectives

What should you be able to do and understand when you have successfully completed the Maths Studies SL course?

Problem-solving is central to learning mathematics and involves the acquisition of mathematical skills and concepts in a wide range of situations, including non-routine, open-ended and real-world problems. Having followed a DP mathematical studies SL course, you will be expected to demonstrate the following.

1. **Knowledge and understanding**: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts.
2. **Problem-solving**: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems.
3. **Communication and interpretation**: transform common realistic contexts into mathematics; comment on the context; sketch or draw mathematical diagrams, graphs or constructions both on paper and using technology; record methods, solutions and conclusions using standardized notation.
4. **Technology**: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems.
5. **Reasoning**: construct mathematical arguments through use of precise statements, logical deduction and inference, and by the manipulation of mathematical expressions.
6. **Investigative approaches**: investigate unfamiliar situations involving organizing and analysing information or measurements, drawing conclusions, testing their validity, and considering their scope and limitations.

Language policy

The language of delivery is English. It is understood that many students have a first language other than English. The majority of first language in the class will be Chinese. Students are permitted to use Chinese to help relate ideas and clarify meaning. However, they are encouraged to master the English terms as most of the biological terms have not direct analogue in Chinese. In addition, the use of Chinese excludes other students who do not understand the language, so it is to be used minimally.

Plagiarism and malpractice

Academic honesty is expected of all students at ZIS. You are responsible for making sure that the work you produce is your own and that you do not offer other people’s work as your own. In addition we expect that as an individual you will not help another pupil to cheat in any way. Your teachers are here to help make sure that you know what this means. Your teachers are responsible for fostering intellectual honesty as well as your intellectual development. To this end they will apply methods of teaching, examination, and assignments that discourage student
dishonesty. If necessary, your teachers will explain clearly any specialized meanings of cheating and plagiarism as they apply to the subjects you study.

For details about what academic malpractice and plagiarism look like, and the processes involved, please see the Secondary School Handbook.

**Expectations**

Following on from the DP Orientation Camp, Mathematics students are expected to:

- Fully engage with the course and their own success in it
- Communicate openly, frequently and respectfully with their teacher
- Develop and follow a study schedule that sees them keep up with the particular demands of the course, as well as the broader reading and learning activity demands too
- Develop comprehensive class notes

1 The IB learner profile encourages learning by experimentation, questioning and discover. Students should be active participants in learning activities rather than recipients of instruction and take up opportunities to learn through mathematical inquiry. This approach is illustrated in figure 1

1 Students should be able to use mathematics to solve problems in the real world. A mathematical modeling process provides opportunities for this. Students should develop, apply and critically analyse models. This approach is illustrated in figure 2

![Figure 1](image1.png)

**FIGURE 1**

![Figure 2](image2.png)

**FIGURE 2**
Course pre-requisites

General:
Students are not required to be familiar with all the topics listed as presumed knowledge (PK) before they start this course. However, they should be familiar with these topics before they take the examinations, because questions assume knowledge of them.

This list of topics is not designed to represent the outline of a course that might lead to the mathematics SL course. Instead, it lists the knowledge, together with the syllabus content, that is essential to successful completion of the mathematics SL course.

<table>
<thead>
<tr>
<th>Content</th>
<th>Further guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Basic use of the four operations of arithmetic, using integers, decimals and fractions, including order of operations. Prime numbers, factors and multiples. Simple applications of ratio, percentage and proportion. Basic manipulation of simple algebraic expressions, including factorization and expansion. Rearranging formulae. Evaluating expressions by substitution. Solving linear equations in one variable. Solving systems of linear equations in two variables. Evaluating exponential expressions with integer values. Use of inequalities (&lt;, \leq, &gt;, \geq). Intervals on the real number line. Solving linear inequalities. Familiarity with commonly accepted world currencies.</td>
<td></td>
</tr>
</tbody>
</table>
| *Examples:*
| \(2(3 + 4 \times 7) = 62\); \(2 \times 3 + 4 \times 7 = 34\). |
| *Examples:*
| \(ab + ac = a(b + c)\); \((x + 1)(x + 2) = x^2 + 3x + 2\). |
| *Example:*
| \(A = \frac{1}{2}bh \quad \Rightarrow \quad h = \frac{2A}{b}\). |
| *Example:*
| If \(x = -3\) then \(x^2 - 2x + 3 = (-3)^2 - 2(-3) + 3 = 18\). |
| *Examples:*
| \(3x + 4 - 3x - 1 = 0\); \(\frac{6x}{5} + 4 = 7\). |
| *Example:*
| \(3x + 4y = 13\), \(\frac{1}{3}x - 2y = -1\). |
| *Examples:*
| \(a^b, b \in \mathbb{Z}\); \(2^{-4} = \frac{1}{16}\); \((-2)^1 = 16\). |
| *Example:*
| \(2 < x \leq 5\), \(x \in \mathbb{R}\). |
| *Example:*
| \(2x + 5 \leq 7 - x\). |
| *Examples:*
| Swiss franc (CHF); United States dollar (USD); British pound sterling (GBP); euro (EUR); Japanese yen (JPY); Australian dollar (AUD). |
The subject and TOK

TOK identifies 8 ways of knowing, and most, if not all, can be argued to have some role in the acquisition of mathematical knowledge. On the surface, mathematical knowledge would appear to have been driven by reason and informed by sensory perception, but what role is there for emotion, intuition and uniquely in Mathematics, language. Certainty and predictability are central in Mathematics but ‘Despite all its undoubted power for understanding and change, mathematics is in the end a puzzling phenomenon. A fundamental question for all knowers is whether mathematical knowledge really exists independently of our thinking about it. Is it there “waiting to be discovered” or is it a human creation?’ (IBO Mathematics SL Guide 2012)

As well as deepening students’ knowledge, thinking and perspectives in Mathematics, incorporating the TOK framework into this course is aimed at supporting students with the TOK course.

While perhaps initially inspired by data from sense perception, mathematics is dominated by reason, and some mathematicians argue that their subject is a language, that it is, in some sense, universal. However, there is also no doubt that mathematicians perceive beauty in mathematics, and that emotion can be a strong driver in the search for mathematical knowledge.

As an area of knowledge, mathematics seems to supply a certainty perhaps missing in other disciplines. This may be related to the “purity” of the subject that makes it sometimes seem divorced from reality. However, mathematics has also provided important knowledge about the world, and the use of mathematics in science and technology has been one of the driving forces for scientific advances.

Despite all its undoubted power for understanding and change, mathematics is in the end a puzzling phenomenon. A fundamental question for all knowers is whether mathematical knowledge really exists independently of our thinking about it. Is it there “waiting to be discovered” or is it a human creation?

Zhuhai International School
IB-DP Math Studies SL Course outline
The subject and the ‘international in International Baccalaureate

Mathematics is in a sense an international language, and, apart from slightly differing notation, mathematicians from around the world can communicate within their field. Mathematics transcends politics, religion and nationality, yet throughout history great civilizations owe their success in part to their mathematicians being able to create and maintain complex social and architectural structures.

The importance of science and technology in the everyday world is clear, but the vital role of mathematics is not so well recognized. It is the language of science, and underpins most developments in science and technology. A good example of this is the digital revolution, which is transforming the world, as it is all based on the binary number system in mathematics.

Contents and skills

Syllabus outline:
The course consists of the study of seven topics – for a total of 150 hrs
Syllabus content is 125 hrs and the Exploration is 25 hrs.
All topics are compulsory. You must study all the sub-topics in each of the topics in the syllabus as listed in this guide.

The topics, and the suggested time for them, are

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Topic</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1</td>
<td>Number &amp; Algebra</td>
<td>20 hrs</td>
</tr>
<tr>
<td>Topic 2</td>
<td>Descriptive statistics</td>
<td>12 hrs</td>
</tr>
<tr>
<td>Topic 3</td>
<td>Logic, sets and probability</td>
<td>20 hrs</td>
</tr>
<tr>
<td>Topic 4</td>
<td>Statistical applications</td>
<td>17 hrs</td>
</tr>
<tr>
<td>Topic 5</td>
<td>Geometry &amp; Trigonometry</td>
<td>18 hrs</td>
</tr>
<tr>
<td>Topic 6</td>
<td>Mathematical Models</td>
<td>20 hrs</td>
</tr>
<tr>
<td>Topic 7</td>
<td>Introduction to differential calculus</td>
<td>18 hrs</td>
</tr>
</tbody>
</table>

Project 25 hrs

The project is an individual piece of work involving the collection of information or the generation of measurements, and the analysis and evaluation of the information or measurements.

In Year 1...
The aim in Year 1 is to complete the first 5 units:
1. Number & Algebra
2. Descriptive statistics
3. Logic, sets & probability
4. Statistical applications
5. Geometry & Trigonometry

In Year 2...
You will have already completed the first year of the Maths Studies SL course, and you have covered 5 of the 7 topics. You will look at the last two topics – Math Models and Differential Calculus – as well as revising content from last year.
There will be internal and external assessments. Both of these are either marked or moderated by IB teachers from other schools than ours.
<table>
<thead>
<tr>
<th>Year 1</th>
<th>Semester I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit Theme</strong></td>
<td><strong>Content</strong></td>
</tr>
</tbody>
</table>
| **Number & Algebra** | 1.1 Natural numbers, N; integers, Z; rational numbers, Q; and real numbers, R .  
1.2 Approximation: decimal places, significant figures. Percentage errors, estimation  
1.3 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.  
1.4 SI (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.  
1.5 Currency conversions.  
1.6 Use of a GDC to solve  
  - pairs of linear equations in two variables  
  - quadratic equations.  
1.7 Arithmetic sequences and series, and their applications.  
Use of the formulae for the $n$th term and the sum of the first $n$ terms of the sequence  
1.8 Geometric sequences and series.  
Use of the formulae for the $n$th term and the sum of the first $n$ terms of the sequence.  
1.9 Financial applications of geometric sequences and series:  
  - compound interest  
  - annual depreciation. | 20 |
| **Descriptive statistics** | 2.1 Classification of data as discrete or continuous.  
2.2 Simple discrete data: frequency tables.  
2.3 Grouped discrete or continuous data: frequency tables; mid-interval values; upper and lower boundaries.  
Frequency histograms  
2.4 Cumulative frequency tables for grouped discrete data and for grouped continuous data; cumulative frequency curves, median and quartiles. Box-and-whisker diagrams  
2.5 Measures of central tendency.  
For simple discrete data: mean; median; mode.  
For grouped discrete and continuous data: estimate of a mean; modal class.  
2.6 Measures of dispersion: range, interquartile range, standard deviation. | 12 |
| Logic, sets & probability | 3.1 Basic concepts of symbolic logic: definition of a proposition; symbolic notation of propositions. |
| | 3.2 Compound statements: implication, \( \Rightarrow \); equivalence, \( \Leftrightarrow \); negation, \( \neg \); conjunction, \( \land \); disjunction, \( \lor \); exclusive disjunction, \( \setminus \). |
| | Translation between verbal statements and symbolic form. |
| | 3.3 Truth tables: concepts of logical contradiction and tautology. |
| | 3.4 Converse, inverse, contrapositive. Logical equivalence. |
| | Testing the validity of simple arguments through the use of truth tables. |
| | 3.5 Basic concepts of set theory: elements \( x \in A \), subsets \( A \subseteq B \); intersection \( A \cap B \); union \( A \cup B \); complement \( A' \). |
| | Venn diagrams and simple applications. |
| | 3.6 Sample space; event \( A \); complementary event, \( A' \). Probability of an event. |
| | Probability of a complementary event. Expected value. |
| | 3.7 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. |
| |  | 20 |
| | Statistical applications | 4.1 The normal distribution. |
| | | The concept of a random variable; of the parameters \( \mu \) and \( \sigma \); of the bell shape; the symmetry about \( x = \mu \). |
| | | Diagrammatic representation. Normal probability calculations. |
| | | Expected value. Inverse normal calculations |
| | 4.2 Bivariate data: the concept of correlation. |
| | | Scatter diagrams; line of best fit, by eye, passing through the mean point |
| | | Pearson’s product–moment correlation coefficient, \( r \). |
| | | Interpretation of positive, zero and negative, strong or weak correlations. |
| | 4.3 The regression line for \( y \) on \( x \). |
| | | Use of the regression line for prediction purposes. |
| | 4.4 The \( \chi^2 \) test for independence: formulation of null and alternative hypotheses; significance levels; contingency tables; expected frequencies; degrees of freedom; \( p \)-values. |
| Geometry & Trigonometry | 5.1 Equation of a line in two dimensions: the forms \( y = mx + c \) and \( ax + by + d = 0 \). |
| |  | 18 |

Zhuhai International School
IB-DP Math Studies SL Course outline
5.1 Gradient; intercepts. Points of intersection of lines.
Lines with gradients, \( m_1 \) and \( m_2 \).
Parallel lines \( m_1 = m_2 \).
Perpendicular lines, \( m 	imes m = -1 \).
5.2 Use of sine, cosine and tangent ratios to find the sides and angles of right-angled triangle
Angles of elevation and depression.
5.3 Use of the sine rule, Use of the cosine rule
Use of area of a triangle \( = \frac{1}{2} ab \sin C \).
5.4 Construction of labelled diagrams from verbal statements.
5.4 Geometry of three-dimensional solids: cuboid; right prism; right pyramid; right cone; cylinder; sphere; hemisphere; and combinations of these solids.
The distance between two points; eg between two vertices or vertices with midpoints or midpoints with midpoints.
The size of an angle between two lines or between a line and a plane.
5.5 Volume and surface areas of the three-dimensional solids defined in 5.4.

<table>
<thead>
<tr>
<th>Semester exam</th>
<th>Everything covered to date</th>
</tr>
</thead>
</table>

### Year 2

<table>
<thead>
<tr>
<th>IA Investigation</th>
<th>Semester III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical models</td>
<td>10</td>
</tr>
</tbody>
</table>

| Mathematical models | 6.1 Concept of a function, domain, range and graph. Function notation, eg \( f(x) \), \( v(t) \), \( C(n) \).
Concept of a function as a mathematical model.
6.2 Linear models. Linear functions and their graphs, \( f(x) = mx + c \)
6.3 Quadratic models.
Quadratic functions and their graphs (parabolas): \( f(x) = ax^2 + bx + c; a \neq 0 \)
Properties of a parabola: symmetry; vertex; intercepts on the x-axis and y-axis.
Equation of the axis of symmetry, \( x = -\frac{b}{2a} \).
6.4 Exponential models.
Exponential functions and their graphs: |
Introduction to differential calculus

7.1 Concept of the derivative as a rate of change. Tangent to a curve.
The derivative of functions of the form
7.2 The principle that
\[ f'(x) = anx^{n-1} \]
The derivative of functions of the form
\[ f(x) = ax^n + bx + \ldots \]
where all exponents are integers.
7.3 Gradients of curves for given values of \( x \).
Values of \( x \) where \( f'(x) \) is given.
Equation of the tangent at a given point.
Equation of the line perpendicular to the tangent at a given point (normal).
7.4 Increasing and decreasing functions. Graphical interpretation of \( f'(x) > 0 \), \( f'(x) = 0 \) and \( f'(x) < 0 \).
7.5 Values of \( x \) where the gradient of a curve is zero. Solution of \( f'(x) = 0 \).
Stationary points. Local maximum and minimum point
7.6 Optimization problems

Semester Exam
Everything covered to date

Semester IV

Revision
12

Mock exams
Scheme Of Work (SOW) – descriptive planner

To be confirmed.

Course materials and textbooks

Main:
Cambridge: Mathematical Studies SL (Mayrick & Dwamena)

Supporting:
Hodder Education: Mathematics Studies for the IB Diploma (Pinmenetel & Wall)  
Oxford University Press: IB Math Studies Course Companion (Bedding et al)  

Periodicals:  
TBA

Websites/blogs/forums:  
TBA

Assessment

Overview:
See the Secondary School Handbook full details of assessment practices and expectations in the Diploma Programme.

There are three types to the assessment of this course

1. **Summative assessment**: These are assessments set at the end of the grading period to determine a student’s performance in that reporting period.

2. **Formative assessments**: These are a variety of tests and assignments set by the subject teacher as part of the teaching and learning process.

3. **Final assessment**: These are the assessments determined by the IB for this course.

Summative Assessments:
Semester grades are determined using the following criteria:

The semester grade is derived by evaluating the student’s current standard at the time of grading. Regardless of which stage of the course the grading is done, students are held against the expected knowledge, understanding and skills required for the entire course.

These grades are based on:

- End of semester exams (Paper 1 and Paper 2)
- In-class Summative tasks, including tests, projects, reports etc
Predicted Grades are determined as follows based on portfolio work and mock exam performance.

**Final Assessment**

**External assessments** (examination) will be over two separate examinations (*Paper 1 & Paper 2*), each 90 minutes long, for a total exam time of 3 hours.

*They will make up 80% of your subject mark.*

<table>
<thead>
<tr>
<th>Paper 1: 1 hr 30 min,</th>
<th>40% of subject mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphic display calculator (GDC) required</td>
<td></td>
</tr>
<tr>
<td>15 compulsory short-response questions based on the whole syllabus. (90 marks)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paper 2: 1 hr 30 min</th>
<th>40% of subject mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphic display calculator (GDC) required</td>
<td></td>
</tr>
<tr>
<td>6 compulsory extended-response questions based on the whole syllabus. (90 marks)</td>
<td></td>
</tr>
</tbody>
</table>

**Internal Assessment** 20% of subject mark

The IA is an individual piece of work involving the collection of information or the generation of measurements, and the analysis and evaluation of the information or measurements. (20 marks). This is a piece of written work based on personal research involving the collection, analysis and evaluation of data. It is marked according to seven assessment criteria.

Students can choose from a wide variety of project types, for example, modelling, investigations, applications and statistical surveys.

The project should not normally exceed 2,000 words, excluding diagrams, graphs, appendices and bibliography. However, it is the quality of the mathematics and the processes used and described that is important, rather than the number of words written.

I can give advice to you on a first draft of the exploration, but this first draft must not be heavily annotated or edited by me. The next version handed to me after the first draft must be the final one.

It is expected that a total of approximately 25 hours should be allocated to the work. This should include:

- time for me to explain to students the requirements of the exploration
- class time for students to work on the exploration
- time for consultation between the me and you
- time to review and monitor progress, and to check authenticity.
This will be marked by me, and externally moderated by other IB-DP teachers from around the world. Each exploration is assessed against the following 7 criteria. The final mark for each exploration is the sum of the scores for each criterion. The maximum possible final mark is 20.

**Criterion A**  Introduction

**Criterion B**  Information/measurement

**Criterion C**  Mathematical processes

**Criterion D**  Interpretation of results

**Criterion E**  Validity

**Criterion F**  Structure and communication

**Criterion G**  Notation and terminology

The specific purposes of the exploration are to:

- develop students’ personal insight into the nature of mathematics and to develop their ability to ask their own questions about mathematics
- encourage students to initiate and sustain a piece of work in mathematics
- enable students to acquire confidence in developing strategies for dealing with new situations and problems
- provide opportunities for students to develop individual skills and techniques, and to allow students with varying abilities, interests and experiences to achieve a sense of personal satisfaction in studying mathematics
- enable students to experience mathematics as an integrated organic discipline rather than fragmentated and compartmentalized skills and knowledge
- enable students to see connections and applications of mathematics to other areas of interest
- provide opportunities for students to show, with confidence, what they know and what they can do.
Command terms with definitions

Students should be familiar with the following key terms and phrases used in examination questions, which are to be understood as described below. Although these terms will be used frequently in examination questions, other terms may be used to direct students to present an argument in a specific way.

Calculate
Obtain a numerical answer showing the relevant stages in the working.

Comment
Give a judgment based on a given statement or result of a calculation.

Compare
Give an account of the similarities between two (or more) items or situations, referring to both (all) of them throughout.

Construct
Display information in a diagrammatic or logical form.

Deduce
Reach a conclusion from the information given.

Describe
Give a detailed account.

Determine
Obtain the only possible answer.

Differentiate
Obtain the derivative of a function.

Draw
Represent by means of a labelled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines. Diagrams should be drawn to scale. Graphs should have points correctly plotted (if appropriate) and joined in a straight line or smooth curve.

Estimate
Obtain an approximate value.

Find
Obtain an answer showing relevant stages in the working.

Hence
Use the preceding work to obtain the required result.

Hence or otherwise
It is suggested that the preceding work is used, but other methods could also receive credit.

Interpret
Use knowledge and understanding to recognize trends and draw conclusions from given information.

Justify
Give valid reasons or evidence to support an answer or conclusion.

Label
Add labels to a diagram.

List
Give a sequence of brief answers with no explanation.

Plot
Mark the position of points on a diagram.

Show
Give the steps in a calculation or derivation.
Key Dates:

- **End of Semester 2, Year 1**
  - Exam on everything from 1st year

- **Summer break between Year 1 and 2**
  - Develop IA

- **End of Semester 1 Year 2**
  - Hand in final internal assessment draft

- **Semester 3 Year 2**
  - Semester Exam

- **Semester 4, Year 2**
  - Mock Exams

- **May 2015**
  - Exams