Diploma Programme subject outline–Group 5: mathematics			
`	Ela Green School	School code	060876
Name of the DP subject *(indicate language)*	Applications and Interpretation HL (English)		
Level *(indicate with X)*	Higher X	Standard completed in two years X	Standard completed in one year *
Name of the teacher who completed this outline	Anuradha Mohan	Date of IB training	Nov 22
Date when outline was completed	20/12/2022	Name of workshop *(indicate name of subject and workshop category)*	Online MAI Category 1

* All Diploma Programme courses are designed as two-year learning experiences. However, up to two standard level subjects, excluding languages ab initio and pilot subjects, can be completed in one year, according to conditions established in the *Handbook of procedures for the Diploma Programme*.

1. Course outline

- Use the following table to organize the topics to be taught in the course. If you need to include topics that cover other requirements you have to teach (for example, national syllabus), make sure that you do so in an integrated way, but also differentiate them using italics. Add as many rows as you need.
- This document should not be a day-by-day accounting of each unit. It is an outline showing how you will distribute the topics and the time to ensure that students are prepared to comply with the requirements of the subject.
- This outline should show how you will develop the teaching of the subject. It should reflect the individual nature of the course in your classroom and should not just be a “copy and paste” from the subject guide.
- If you will teach both higher and standard level, make sure that this is clearly identified in your outline.

	Topic/unit (as identified in the IB subject guide) *State the topics/units in the order you are planning to teach them.*	Contents	Allocated On 45 minutes. In on 6 classes.	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
	Introduction	Course Introduction		Formative Tasks	
				Prior knowledge: Number systems: natural numbers $\mathbb{N}$; integers, $\mathbb{Z}$; rationals, $\mathbb{Q}$, and irrationals; real numbers, $\mathbb{R}$ • SI (Système International) units for mass, time, length, area and volume and their derived units, eg. speed • Rounding, decimal approximations and significant figures, including appreciation of errors • Definition and elementary treatment of absolute value (modulus), a • Use of addition, subtraction, multiplication and division using integers, decimals and fractions, including order of operations	

				• Prime numbers, factors (divisors) and multiples • Greatest common factor (divisor) and least common multiples (HL only) • Simple applications of ratio, percentage and proportion • Manipulation of algebraic expressions, including factorization and expansion • Rearranging formulae • Calculating the numerical value of expressions by substitution • Evaluating exponential expressions with simple positive exponents • Evaluating exponential expressions with rational exponents (HL only) • Use of inequalities, $<$, $\leq$, $>$, $\geq$, intervals on the real number line • Simplification of simple expressions involving roots (surds or radicals) • Rationalising the denominator (HL only) • Expression of numbers in the form $a \times 10k$, $1 \leq a < 10$, $k \in \mathbb{Z}$ • Familiarity with commonly accepted world currencies • Solution of linear equations and inequalities	

				• Solution of quadratic equations and inequalities with rational coefficients (HL only) • Solving systems of linear equations in two variables • Concept and basic notation of sets. Operations on sets: union and intersection • Addition and subtraction of algebraic fractions (HL only).	

Year 1	Unit 1: Number & Algebra	**SL 1.1** Operations with numbers in the form a × 10k where 1 ≤ a < 10 and k is an integer. **SL 1.2** Arithmetic sequences and series. Use of the formulae for the nth term and the sum of the first n terms of the sequence. Use of sigma notation for sums of arithmetic sequences. Applications. Analysis, interpretation and prediction where a model is not perfectly arithmetic in real life. **SL 1.3** Geometric sequences and series. Use of the formulae for the nth term and the sum of the first n terms of the sequence. Use of sigma notation for the sums of geometric sequences. Applications. **SL 1.4** Financial applications of geometric sequences and series: • compound interest • annual depreciation. **SL 1.5** Laws of exponents with integer exponents. Introduction to logarithms with base 10 and e. Numerical evaluation of logarithms using technology **SL 1.6** Approximation: decimal places, significant	29 hours SL – 16 hrs HL – 13 hrs	**Formative Assessment:** **Weekly quizzes** **Unit quizzes and test. Projects** A&I | Mr Mac Maths **Summative Assessment:** Past IB papers **ATL: Communication skills** **Connection to Concept:** Number and algebra allow us to represent patterns, show equivalencies and make generalizations which enable us to model real-world situations. Algebra is an abstraction of numerical concepts and employs variables to solve mathematical problems **LPA**: Knpwledgeable **EE:** Exploring the application of number theory in Cryptography and information security. Investigating the properties of fractals and their applications in Computer graphics and image processing.	Financial Applications | DP IB Maths: AI SL Questions & Answers 2021 (Medium) | Save My Exams What is Amortization: Definition, Formula, Examples (deskera.com) Ch 6.3 - Geometric Sequences (cacmath.org)

		figures. Upper and lower bounds of rounded numbers. Percentage errors Estimation. **SL 1.7** Amortization and annuities using technology **SL 1.8** Use technology to solve: • Systems of linear equations in up to 3 variables • Polynomial equations **AHL 1.9** Laws of logarithms: $\log_a xy = \log_a x + \log_a y$ $\log_a x\, y = \log_a x \ldots \log_a y$ $\log_a x^m = m \log_a x$ for a, x, y > 0 **AHL 1.10** Simplifying expressions, both numerically and algebraically, involving rational exponents. **AHL 1.11** The sum of infinite geometric sequences. **AHL 1.12** Complex numbers: the number i such that $i^2 = -1$. Cartesian form: z = a + bi; the terms real part, imaginary part, conjugate, modulus and argument. The complex plane.		**TOK:** Is all knowledge concerned with identification and use of patterns? Consider Fibonacci numbers and connections with the golden ratio **CAS:** Learn to maintain financial accounts for a local charity.	

		Complex numbers as solutions to quadratic equations of the form $ax^2 + bx + c = 0$, $a \neq 0$, with real coefficients where $b^2 - 4ac < 0$. **AHLL.13** Modulus–argument (polar) form: Exponential form: $z = re^{i\theta}$ $z = r\cos\theta + i\sin\theta = r\text{cis}\theta$. Conversion between Cartesian, polar and exponential forms, by hand and with technology Calculate products, quotients and integer powers in polar or exponential forms. Adding sinusoidal functions with the same frequencies but different phase shift angles Geometric interpretation of complex numbers. **AHL 1.14**: Definition of a matrix: the terms element, row, column and order for $m \times n$ matrices. Algebra of matrices: equality; addition; subtraction; multiplication by a scalar for $m \times n$ matrices. Multiplication of matrices. Properties of matrix multiplication: associativity, distributivity and non-commutativity. Identity and zero matrices. Determinants and inverses of $n \times n$ matrices with technology, and by hand for 2×2 matrices. Awareness that a system of linear equations can be written in the form $Ax = b$. Solution of the systems of equations using inverse matrix.			

	Topic 2: Functions	**SL 2.1** Different forms of the equation of a straight	42 hours SL-31	**Formative Assessment** Illustrative Mathematics	Tower of Hanoi recursion game
	Topic 3: Geometry &	**SL 3.1** The distance between two points in	42 hours SL 183	**Formative Assessment:** **5 W's and H**	L7.pdf (mit.edu) The fascinating world
Year 2	**Topic 4: Statistics & Probability**	**SL 4.1** Concepts of population, sample, random sample, discrete and continuous data. Reliability of data sources and bias in sampling. Interpretation of outliers. Sampling techniques and their effectiveness **SL 4.2** Presentation of data (discrete and continuous): frequency distributions (tables). Histograms. Cumulative frequency; cumulative frequency graphs; use to find median, quartiles, percentiles, range and interquartile range (IQR). Production and understanding of box and whisker diagrams. **SL 4.3** Measures of central tendency (mean, median and mode). Estimation of mean from grouped data Modal class. Measures of dispersion (interquartile range, standard deviation and variance). Effect of constant changes on the original data. Quartiles of discrete data. **SL 4.4** Linear correlation of bivariate data. Pearson's product-moment correlation coefficient, r Scatter diagrams; lines of best fit, by eye, passing through the mean point. Equation of the regression line of y on x. Use of	52 hours SL-36 HL-16	**Formative Assessment** Topic-wise questions for practice Math AI - Exercise (christosnikolaidis.com) **Summative Assessment:** Past IB papers **ATL:** Research skills **LPA:** Balanced **EE;** Investigating the role of Statistics in decision-making And forecasting. Exploring the application of game theory in economics and decision making A statistical analysis of factors affecting fatal road accidents during the festive season. **TOK:** Why have mathematics and statistics sometimes been treated as separate subjects? How easy is it to be misled by statistics? Is it ever justifiable to purposely use statistics to	Measures of Central Tendency - GeeksforGeeks [PDF Notes] What is the Importance of Measures of Central Tendency in Statistics? 2023 (engineeringintervie wquestions.com) https://www.bing.com/search?q=normal+distribution+pdf&cvid=36b8f69c293941e085e9d2a45bda45c1&aqs=edge.0.0l9.6026j0j1&pglt=43&FORM=ANNTA1&PC=DCTS

		the equation of the regression line for prediction purposes. Interpret the meaning of the parameters, a and b, in a linear regression y = ax + b. **SL 4.5** Concepts of trial, outcome, equally likely outcomes, relative frequency, sample space (U) and event. The probability of an event A is $\mathrm{P}(A) = \frac{n(A)}{n(U)}$. The complementary events A and A' (not A). Expected number of occurrences **SL 4.6** Use of Venn diagrams, tree diagrams, sample space diagrams and tables of outcomes to calculate probabilities Combined events: $\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B)$. Mutually exclusive events: $\mathrm{P}(A \cap B) = 0$. Conditional probability: $\mathrm{P}(A \mid B) = \frac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$. Independent events: $\mathrm{P}(A \cap B) = \mathrm{P}(A)\mathrm{P}(B)$ **SL 4.7** Concept of discrete random variables and their probability distributions. Expected value (mean), E X for discrete data. Applications. **SL 4.8** Binomial distribution. Mean and variance of the binomial distribution. **SL 4.9** The normal distribution and curve. Properties of the normal distribution. Diagrammatic representation. Normal probability calculations. Inverse normal calculations		mislead others? **CAS:** Research Survey	

		SL 4.10 Spearman's rank correlation coefficient, rs . Awareness of the appropriateness and limitations of Pearson's product moment correlation coefficient and Spearman's rank correlation coefficient, and the effect of outliers on each. **SL 4.11** Formulation of null and alternative hypotheses, H0 and H1 . Significance levels. p –values Expected and observed frequencies The χ^2 test for independence: contingency tables, degrees of freedom, critical value. The χ^2 goodness of fit test. The t -test. Use of the p -value to compare the means of two populations. Using one-tailed and two-tailed tests. **HL 4.12** Design of valid data collection methods, such as surveys and questionnaires. Selecting relevant variables from many variables. Choosing relevant and appropriate data to analyse. Categorizing numerical data in a χ 2 table and justifying the choice of categorisation. Choosing an appropriate number of degrees of freedom when estimating parameters from data when carrying out the χ 2 goodness of fit test Definition of reliability and validity. Reliability tests. Validity tests. **HL 4.13** Regression with non-linear functions. Evaluation of least squares regression curves using technology. Sum of square residuals (SSres) as a measure of			

		fit for a model The coefficient of determination (R^2). Evaluation of R^2 using technology. **HL 4.14** Linear transformation of a single random variable Expected value of linear combinations of n random variables. Variance of linear combinations of n independent random variables. $\bar{x}$ as an unbiased estimate of μ s_{n-1}^2 as an unbiased estimate of σ^2. **HL 4.15** A linear combination of n independent normal random variables is normally distributed. In particular, $X \sim \mathrm{N}(\mu, \sigma^2) \Rightarrow \bar{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$. Central limit theorem. **HL 4.16** Confidence intervals for the mean of a normal population. **HL 4.17** Poisson distribution, its mean and variance. Sum of two independent Poisson distributions has a Poisson distribution **HL 4.18** Critical values and critical regions Test for population mean for normal distribution. Test for proportion using binomial distribution Test for population mean using Poisson			

		distribution Use of technology to test the hypothesis that the population product moment correlation coefficient (ρ) is 0 for bivariate normal distributions. Type I and II errors including calculations of their probabilities **HL 4.19** Transition matrices. Powers of transition matrices. Transition matrices. Powers of transition matrices. Calculation of steady state and long-term probabilities by repeated multiplication of the transition matrix or by solving a system of linear equations			
	Topic 5: Calculus	**SL 5.1** Introduction to the concept of a limit.	41 hours SL-19	**Formative Assessment**	Quotient Rule - Stationary Points,
	Mathematical Exploration	Work on the exploration will be incorporated into the course so that	10 hours	Internal Assessment - IB DP Mathematics SL (weebly.com)	

2. IB internal assessment requirement to be completed during the course

Briefly explain how and when you will work on it. Include the date when you will first introduce the internal assessment requirement to your students, the different stages and when the internal assessment requirement will be due.

Students will first be introduced to their internal assessment during the second semester of year 1.
Students will then be required to state their thesis topic by the end of year 1.
Students will need to have a first draft done by the end of the first semester year 2 with their final draft due in February.

3. Links to TOK

You are expected to explore links between the topics of your subject and TOK. As an example of how you would do this, choose one topic from your course outline that would allow your students to make links with TOK. Describe how you would plan the lesson.

Topic	Link with TOK (including description of lesson plan)
Series	Students will look at how mathematics often appears in nature. Specifically exploring π, e,ϕ,and Fibonacci numbers and how this may connect to mathematical knowledge. Knowledge Questions: T o what extend mathematics describe the real world? Was maths discovered or invented?
Functions	Is the same rigor of mathematics required to look at a function graphically, numerically, algebraically, and/or analytically? Knowledge Questions to be explored: Does mathematical knowledge depend on the mathematical representation? Is mathematics better defined by its subject matter or its representation? Can mathematician trust their results?
Trigonometric equations	Students will discuss how there can be an infinite number of discrete solutions to an equation? Knowledge Questions to be explored: Is absolute certaintly attainable in mathematics. What is it about mathematics that enables mathematical results to remain unchanged over time?

4. Approaches to learning

Every IB course should contribute to the development of students' approaches to learning skills. As an example of how you would do this, choose one topic from your outline that would allow your students to specifically develop one or more of these skill categories (thinking, communication, social, self-management or research).

Topic	Contribution to the development of students' approaches to learning skills (including one or more skill category)
Exponential functions	How is the term "exponential growth" used in real life? Is this a misleading use of a mathematical term to describe such phenomena? This topic can be explored to trigger the critical thinking skills of students.

Vectors	Students will research about the various applications of vectors in the real world and how the application of navigation can be for the better good or for bad. This topic can be used to enhance the creative thinking and research skills of students.

5. International mindedness

Every IB course should contribute to the development of international-mindedness in students. As an example of how you would do this, choose one topic from your outline that would allow your students to analyse it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

Topic	Contribution to the development of international mindedness (including resources you will use)
Binomial Theorem	Students will look at all the properties of Pascal's triangle and explore how they were used/known in different cultures long before Pascal's time.
Functions	When and where was the idea of function notation developed and how did it become accepted today internationally?
Trigonometry	Students will explore how degrees originated in Mesopotamia and why we use minutes and seconds for times

6. Development of the IB learner profile

Through the course it is also expected that students will develop the attributes of the IB learner profile. As an example of how you would do this, choose one topic from your course outline and explain how the contents and related skills would pursue the development of any attribute(s) of the IB learner profile that you will identify.

Topic	Contribution to the development of the attribute(s) of the IB learner profile
Calculus	Students are reflective as they learn the topic of calculus. They are able to look at their foundational skills that have prepared them in understanding the concepts of calculus. They are also inquirers as they explore how and why calculus was developed
Statistics	Students are thinkers as they look at data and how it drives decisions they make as a student and decisions made in the world around them.

Functions	Students will display open-mindedness as they discuss analyzing functions graphically, numerically, and algebraically. They will look at if and when one form is better or more accessible than the other and are there times when one is not appropriate. Are all forms of a function equally as rigorous as the other?

7. Resources

Describe the resources that you and your student will have to support the subject. Indicate whether they are sufficient in terms of quality, quantity and variety. Briefly describe what plans are in place if changes are needed.

Oxford publications
Haese and Harris publications
Pearson publications
Cambridge publications
Heinamann publi
www.savemyexams.com
www.iitanacademy.com
www.thinkib.com
www.ibo.org
www.ibtaskmaker.com
www.ibmaths.com
www.revisionvillage.com
www.mrmacmaths.com
www.ibresources.com
www.ibfreeresources.com
www.ibelitecouk.com
www.ibmaths.com
www.tes.com
www.mathsplus.org
http://kimkimsl.weebly.com/