

Appendix 5

IB Diploma Programme course outlines

Teachers responsible for each proposed subject must prepare a course outline following the guidelines below. While IB subject guides will be used for this exercise, teachers are expected to adapt the information in these guides to their own school's context. Please be sure to use IBO nomenclature throughout. The name of the teacher(s) who wrote the course outline must be recorded at the top of the outline.

Name of the teacher who prepared the outline:

Brandon Clay

Name of the course:

IB Math HL 1AB/2AB

Course description:

The Mathematics HL course sequence is intended for students with a good background in mathematics who are competent in a range of analytical and technical skills. This sequence is appropriate for those who intend to study in fields which include a major component of mathematics like engineering, the physical or biological sciences, business, and technology. Students intending to study in other fields may choose this sequence to learn about a broad range of mathematics and its applications. A student would also choose this sequence as a means of satisfying their own natural curiosity of the subject, of improving their critical thinking and problem solving skills, or be a risk-taker and explore a subject in which they may be challenged.

The Mathematics HL course will complement the Theory of Knowledge class by encouraging students to gain strong understanding of a broad base of mathematics by exploring new ideas through the four ways they acquire knowledge: senses, reason, language, and emotion. Real world problems will be discussed as means of launching mathematical inquiry into new mathematical concepts as a way of balancing applied and theoretical approaches to mathematics. The course will cover how many mathematical achievements or mathematicians impacted the international scene, influenced public policy, and how the historical and cultural context in which a mathematical discovery was made may have spawned its discovery or influenced the emotional state of a particular mathematician. Statistics will be analyzed for their validity and their use to ethically or unethically manipulate public opinion. Students will collect information on real world problems using their senses and find solutions in laboratory experiments. Mathematics will be studied as a universal language that can be used to communicate ideas internationally.

The preparation for the Mathematics HL papers and portfolio is accomplished by completing the course sequence is Honors Algebra 2AB, Honors Precalculus 1AB, IB Math HL 1AB, and IB Math HL 2AB. All of the courses will have written examinations where students demonstrate knowledge of mathematical skills using correct terminology, notation, critical thinking and problem solving strategies, clear communication, and how to determine the reasonableness of their solutions even when faced with real world problems in which they are unfamiliar. The IB Mathematics HL class will require a portfolio which is a collection of two pieces of work focusing on two different areas of content in the syllabus. The portfolio will require mathematical investigation and modeling of a real life problem in which the student has a natural inquiry. Students will demonstrate an in-depth knowledge of two or more concepts directly studied in the topic outline. Students will explore and reflect upon multiple strategies that could be used to solve the problem and determine the most effective method(s) and the reasonableness of their conclusions. The portfolio will be an internal assessment and be worth 20% of the overall assessment. The external assessment will be worth 80% of the overall assessment and will consist of three written papers. Paper 1 and 2 will assess the core content of the syllabus and Paper 3 will assess the option syllabus content (Topic 10).

Topics:

Core: Algebra	Content	Semester	Hours
1.1	Arithmetic sequences and series; sum of finite arithmetic series; geometric sequences and series; sum of finite and infinite geometric series. Sigma notation	Spring, year 2	6
1.2	Exponents and logarithms. Laws of exponents; laws of logarithms. Change of base	Spring, year 2	2
1.3	Counting Principles, including permutations. The binomial theorem: expansion of $(a+b)^n$, $n \in \mathbb{N}$	(Honors Pre- calculus)	
1.4	Proof by Mathematical Induction. Forming conjectures to be proved by mathematical induction.	(Honors Pre- calculus)	
1.5	Complex numbers: the number $i = \sqrt{-1}$; the terms real part, imaginary part, conjugate, modulus, and argument. Cartesian form of $z = a + bi$ Modulus-argument form $z = r \operatorname{cis} \theta = r(\cos \theta + i \sin \theta)$. The complex plane.	(Honors Pre- calculus)	
1.6	Sums, products, and quotients of complex numbers	(Honors Pre- calculus)	
1.7	De Moivre's Theorem. Powers and roots of a complex number.	(Honors Pre- calculus)	
1.8	Conjugate roots of polynomial equations with real coefficients.	(Honors Pre- calculus)	

Core: Functions & Equations	Content	Semester	Hours
2.1	Concept of function $f : x \rightarrow f(x)$: domain, range; image (value). Composite functions $f \circ g$; identity function. Inverse function f^{-1}	Fall, year 1	3
2.2	The graph of a function; its equation $y = f(x)$. Function graphing skills: use of a graphing calculator to graph a variety of functions, investigation of key features of graphs, solutions of equations graphically.	Fall, year 1	4.5

2.3	Transformations of graphs: translations; stretches; reflections in the axes. The graph of $y = f^{-1}$ as the reflection in the line $y = x$ of the graph of $y = f(x)$. The graph of $y = \frac{1}{f(x)}$ from $y = f(x)$. The graphs of the absolute value functions, $y = f(x) $ and $y = f(x)$.	Fall, year 1	3
2.4	The reciprocal function $f(x) = \frac{1}{x}, x \neq 0$: its graph; its self-inverse nature	Fall, year 1	0.5
2.5	The quadratic function: $f(x) = ax^2 + bx + c$: its graph. Axis of symmetry $x = -\frac{b}{2a}$. Form $f(x) = a(x-h)^2 + k$ Form $f(x) = a(x-p)(x-q)$	Fall, year 1	1.5
2.6	The solution of $ax^2 + bx + c = 0$. The quadratic formula. Use of the discriminant.	Fall, year 1	0.5
2.7	The function $f(x) = a^x, a > 0$. The inverse function $f(x) = \log_a x, x > 0$. Graphs of $y = a^x$ and $y = \log_a x$. Solutions of $a^x = b$ using logarithms.	Fall, year 1	1
2.8	The exponential function $f(x) = e^x$ and the logarithmic function $f(x) = \ln x, x > 0$.	Fall, year 1	1
2.9	Inequalities in one variable, using their graphical representation. Solution of $g(x) \leq f(x)$, where f, g are linear or quadratic	Fall, year 1	3
2.10	Polynomial Functions. The factor and remainder theorems, with applications to the solution of polynomial equations and inequalities.	Fall, year 1	1.5

Core: Circular Functions & Trigonometry	Content	Semester	Hours
3.1	The circle: radian measure of angles; length of an arc; area of a sector	Fall, year 1	1.5
3.2	Definition of $\cos \theta$ and $\sin \theta$ in terms of the unit circle. Definition of $\tan \theta$ as $\frac{\sin \theta}{\cos \theta}$. Definition of $\sec \theta$, $\cot \theta$, and $\csc \theta$. Pythagorean identities: $\sin^2 \theta + \cos^2 \theta = 1$; $\tan^2 \theta + 1 = \sec^2 \theta$; $1 + \cot^2 \theta = \csc^2 \theta$	Fall, year 1	2.5
3.3	Compound angle identities. Double angle identities	Fall, year 1	1
3.4	The circular functions $\sin x$, $\cos x$, and $\tan x$; their domains and ranges; their periodic nature; their graphs. Composite functions of the form $f(x) = a \sin[b(x+c)] + d$. The inverse functions $f(x) = \arcsin x$, $f(x) = \arccos x$, and $f(x) = \arctan x$ their domains and ranges; their graphs.	Fall, year 1	2
3.5	Solutions of trigonometric equations in a finite interval. Use of trigonometric identities and factorization to transform equations	Fall, year 1	2
3.6	Solution of Triangles: law of cosines, law of sines, area of a triangle as $\frac{1}{2}ab\sin C$	(Honors Pre-calculus)	

Core: Matrices	Content	Semester	Hours
4.1	Definition of a matrix: the terms element, row, column, and order	(Honors Pre-calculus)	
4.2	Algebra of matrices: equality; addition; subtraction; multiplication by a scalar. Multiplication of matrices. Identity and zero matrices	(Honors Pre-calculus)	
4.3	Determinant of a square matrix. Calculation of 2x2 and 3x3 determinants. Inverse of a matrix: conditions for existence	(Honors Pre-calculus)	
4.4	Solution of systems of linear equations. Conditions for existence of a unique solution, no solution, and infinitely many solutions	(Honors Pre-calculus)	0.5

Core: Vectors	Content	Semester	Hours
5.1	Vectors as displacement in the plane and in three dimensions. Components of vector; column representations Algebraic and geometric approaches to the following topics: sum and difference of two vectors, the zero vector, the opposite vector, multiplication by scalar, unit vector, position vectors	Spring, year 2	3
5.2	The scalar product of two vectors. Algebraic properties of the scalar product. Perpendicular vectors, parallel vectors. Angle between two vectors	Spring, year 2	1.5
5.3	Vector equation of a line $r = a + \lambda b$ The angle between two lines.	Spring, year 2	1.5
5.4	Coincident, parallel, intersecting, and skew lines, distinguishing between these cases. Points of intersection	Spring, year 2	1.5
5.5	The vector product of two vectors. The determinant representation. Geometric interpretation of $ v \times w $	Spring, year 2	3
5.6	Vector equation of a plane $r = a + \lambda b + \mu c$. Use of a normal vector to obtain the form $r \cdot n = a \cdot n$. Cartesian equation of a plane $ax + by + cz = d$	Spring, year 2	3

Core: Statistics & Probability	Content	Semester	Hours
6.1	Concepts of population, sample, random sample and frequency distributions of discrete and continuous data	Fall, year 2	3
6.2	Presentation of data: frequency tables, diagrams, box and whisker plots. Group data: mid-interval values, interval width, upper and lower interval boundaries, frequency histograms	Fall, year 2	3
6.3	Mean, median, mode, quartiles, percentiles Range: interquartile range, variance, standard deviation	Fall, year 2	3
6.4	Cumulative frequency, cumulative frequency graphs; use to find median, quartiles, and percentiles	Fall, year 2	3
6.5	Concepts of trial, outcome, equally likely outcomes, sample space (U), and event. Probability of an event A as $P(A) = n(A)/n(U)$. Complementary events A and A' $P(A) + P(A') = 1$	Fall, year 2	4.5
6.6	Combined events, the formula	Fall, year 2	3

	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$ $P(A \cap B) = 0$ for mutually exclusive events	2	
6.7	Conditional Probability; the definition $P(A B) = \frac{P(A \cap B)}{P(B)}$ Independent Events; the definition $P(A B) = P(A) = P(A B')$ Use of Bayes' Theorem for two events	Fall, year 2	4.5
6.8	Use of Venn Diagrams, tree diagrams and tables of outcomes to solve problems.	Fall, year 2	3
6.9	Concept of discrete and continuous random variables and their probability distributions. Definition and use of probability density functions. Expected value (mean), mode, median, variance, and standard deviation.	Fall, year 2	4.5
6.10	Binomial distribution, its mean and variance. Poisson distribution, its mean and variance.	Fall, year 2	4
6.11	Normal distribution. Properties of normal distribution. Standardization of normal distribution	Fall, year 2	4.5

Core: Calculus	Content	Semester	Hours
7.1	Informal ideas of limit and convergence. Definition of a derivative. Derivative of $\sin x$, $\cos x$, $\tan x$, $\ln x$, and the natural exponential function. Derivative interpreted as a gradient function and as a rate of change Derivatives of reciprocal circular functions. Derivatives of a^x and $\log_a x$. Derivatives of $\arcsin x$, $\arctan x$, and $\arccos x$.	Fall & Spring, year 1	15
7.2	Differentiation of a sum and real multiple of the functions in 7.1. The chain rule for composite functions. Application of chain rule to related rates of change. The product and quotient rules. The second derivative. Awareness of higher order derivatives	Fall & Spring, year 1	12
7.3	Local extrema points. Use of the first and second derivative in optimization problems	Fall & Spring, year 1	10.5
7.4	Indefinite integration as anti-differentiation. Indefinite	Fall & Spring,	7.5

	integral of x^n , $\sin x$, $\cos x$, e^x , $\frac{1}{x}$. The composites of any of these with the linear function $ax + b$	year 1	
7.5	Anti-differentiation with a boundary condition to determine the constant term. Definite integrals. Area between a curve and the x-axis or y-axis in a given integral, areas between curves. Volumes of revolution.	Spring, year 1	10.5
7.6	Kinematic problems involving displacement, s, velocity, v, and acceleration, a.	Fall & Spring, year 1	6
7.7	Graphical behavior of functions: tangents and normals, behavior for large $ x $; asymptotes	Fall, year 1	4.5
7.8	Implicit Differentiation	Fall, year 1	4.5
7.9	Further integration: integration by substitution, integration by parts	Spring, year 1	10.5
7.10	Solution of first order differential equations by separation of variables	Spring, year 1	4.5

Option: Series & differential equations	Content	Semester	Hours
10.1	Infinite sequences of real numbers. Limit theorem as n approaches infinity. Limit of a sequence. Improper integrals of the form $\int_a^\infty f(x) dx$. The integral as a limit of a sum; lower sum and upper sum.	Spring, year 2	7.5
10.2	Convergence of infinite series. Partial fractions as telescoping series. Tests for convergence: comparison test; limit comparison test; ratio test; integral test. The p-series. Use of integrals to estimate sums of series.	Spring, year 2	10.5
10.3	Series that converge absolutely. Series that converge conditionally. Alternating series.	Spring, year 2	4.5
10.4	Power series: radius of convergence and interval of convergence. Determination of the radius of convergence by the ratio test.	Spring, year 2	6
10.5	Taylor polynomial and series, including error term. Maclaurin series for e^x , $\sin x$, $\cos x$, $\arctan x$, $\ln(1+x)$, $(1+x)^p$. Use of substitution to obtain other series. Evaluation of limits using l'Hopital's Rule and/or the Taylor	Spring, year 2	6

	Series.		
10.6	First order differential equations: geometric interpretation using slope fields; numerical solution of $\frac{dy}{dx} = f(x, y)$ using Euler's method. Homogeneous differential equations: $\frac{dy}{dx} = f\left(\frac{y}{x}\right)$ using $y = vx$. Solution of $y' + P(x)y = Q(x)$, using the integrating factor.	Spring, year 2	7

Assessment	Content	Semester	Hours
Portfolio	Mathematical Investigation will be assigned and worked on during the 5 class hours prior to the winter recess and will be completed and turned in the first part of January.	Fall, year 2	5
Portfolio	Mathematical Modeling will be assigned and worked on during the last 5 class hours at the end of May and will be completed and turned in the first part of June.	Spring, year 2	5

AP Calculus	Content	Semester	Hours
Continuity as a property of functions. - An intuitive understanding of continuity. (Close values of the domain lead to close values of the range.) - Understanding continuity in terms of limits. - Geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem).		Fall, year 1	3
Second derivatives. - Corresponding characteristics of the graphs of f, f', and f''. - Relationship between the concavity of f and the sign of f''. - Points of inflection as places where concavity changes.		Fall, year 1	3
L'Hôpital's Rule		Fall, year 1	1.5

Applications of antidifferentiation - Numerical approximations to definite integrals. Use of Riemann and trapezoidal sums to approximate definite integrals of functions represented algebraically, geometrically, and by tables of values. - Using the integral of a rate of change to give accumulated change or using the method of setting up an approximating Riemann sum and representing its limit as a definite integral	Spring, year 1	6
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Assessment:

External assessment 5 hrs 80%

Written papers

Paper 1 2 hrs 30%

No calculator allowed

Section A 15%

Compulsory short-response questions based on the compulsory core of the syllabus

Section B 15%

Compulsory extended-response questions based on the compulsory core of the syllabus

Paper 2 2 hrs 30%

Graphic display calculator (GDC) required

Section A 15%

Compulsory short-response questions based on the compulsory core of the syllabus

Section B 15%

Compulsory extended-response questions based on the compulsory core of the syllabus

Paper 3 1 hr 20%

Graphic display calculator (GDC) required

Extended-response questions based mainly on the syllabus options

Internal assessment 20%

Portfolio

A collection of two pieces of work assigned by the teacher and completed by the student during the course. The pieces of work must be based on different areas of the syllabus and represent the two

types of tasks:

- mathematical investigation
- mathematical modelling.

The portfolio is internally assessed by the teacher and externally moderated by the IBO. Procedures are provided in the *Vade Mecum*.

Resources:

Author	Title	Publisher and Date
R. Finney, F. Demana, B. Waits, and D. Kennedy	Calculus: Graphical, Numerical, Algebraic *AP Edition, 3rd Edition	Pearson Prentice Hall 2007
D. Lederman	Multiple Choice & Free Response Questions in Preparation for the AP Calculus (AB) Examination, 8th edition	D & S Marketing Systems, Inc. 2004
M. Sullivan and M. Sullivan III	Precalculus: Enhanced with Graphing Utilities, 3rd edition	Prentice Hall 2003
D. Yates, D. Moore, and D. Starnes	The Practice of Statistics: TI-83/89 Graphing Calculator Enhanced, 2nd Edition	W.H. Freeman and Company 2002
R. Larson, R. Hostetler, and B. Edwards	Calculus with Analytic Geometry, 8th edition	Houghton Mifflin Company 2006
C. Boyer	A History of Mathematics	John Wiley and Sons, Inc. 1991
E. T. Bell	Men of Mathematics	Simon and Schuster, 1965
M. Lewinter and W. Widulski	The Saga of Mathematics: A Brief History	Prentice Hall, 2002
L. Osen	Women in Mathematics	1974 Massachusetts Institute of Technology

Teaching time:

List all classroom teaching hours for each HL and SL course. Explain how the hours are calculated.

HL course	Teaching hours
IB Math HL 1AB and 2AB	The total number of teaching hours is found by adding all of the instructional hours used in IB Math HL 1AB and 2AB to teach all of the required topics 1-7 for the Mathematics HL plus Topic 10 of the optional syllabus content. 241 hours. Note: some of the required content is covered in prior courses that are prerequisites for the IB Math HL 1AB and 2AB course sequence.

For group 5 subjects:

- **Does the course provide adequate training in analytical and critical thought?**

Writing assignments enhances students' reasoning skills and make them comfortable discussing mathematical concept. Data modeling requires students to find and interpret mathematical models from real life data. Critical thinking exercises are thought provoking conceptual problems that help students grasp the theories covered.

- **Have courses been sequenced to provide appropriate preparation for the various mathematics options and computer science?**

The sequence of courses follows algebra 2, trigonometry, pre-calculus, and then calculus and statistics. All topics are thoroughly covered to help ensure mastery of all prerequisite skills which will allow students to have a strong foundation and therefore more success at understanding calculus, statistics, and more advanced courses at the collegiate level.

- **How will the international perspective of your students be enhanced by the methodology and resources used in the teaching of mathematics/computer science?**

Students are encouraged to use a graphing calculator (TI-83/84+) as a tool for exploration, discovery, and problem solving. The use of a graphing calculator increases the understanding of the concept being taught. Students will learn to use international math symbols so that they may communicate with other mathematicians around the world. Students will also learn how mathematical discovery shaped the course of human history or how particular social environments may have driven discovery in mathematics.

- **Does the classroom and/or library contain a variety of modern mathematics textbooks, technical reference materials and other supplementary instructional materials to support the course(s) in IB mathematics?**

The classroom contains the mathematical textbooks listed above in the resources section as well as many other mathematics titles not used in regular classroom instruction. Students also have access to the Newport Beach Main Library and the Science Library at U.C. Irvine where many modern mathematics textbooks, technical reference materials, research, and support materials may be found and used as a source.

For all subjects:

- **Has a thorough review of the available resource materials and equipment (both within the department and in the library/media centre) been conducted?**

Yes.

- **Are instructional materials available in sufficient quality, quantity and variety to give effective support to the aims and methods of the courses?**

There are sufficient text and supplementary materials within the mathematics department at the school to support the aims and methods of the courses in pre-calculus, calculus, and statistics. The classrooms are equipped with TI-83/84+ graphing calculators, scientific calculators, LCD projectors, two or more computers, a DVD player, and SMART Board. The library will be equipped with full labs of computers, a multimedia room, copiers, and other instructional resources.

- **Are community resources used both within the classroom and as part of regular field trips?**

Students can participate in the career mentor program in which students are paired with local professionals in a field that the student expresses interest. The student and the mentor work together on job shadowing days and other meeting times to help the student gain a complete picture of what each job actually required in terms of education, experience, commitment, as well as working conditions. Field trips to John Wayne Airport, San Diego Aeronautical Museum, the Boeing plant in Long Beach are all readily accessible. Many students participate in the senior trip to Costa Rica

- **Are the needs and projected costs of acquiring all necessary materials and equipment for each subject group clearly stated?**

Yes.

- **Is an international perspective included?**

Yes. Multicultural education will be addressed throughout the curriculum. Students may participate in a trip to Costa Rica for an international perspective.