Curriculum Map for Mathematics HL (DP1)

Unit Title (Time frame)	Standards	IB Objectives	Knowledge/Content	Skills	Assessments	Key resources
Sequences and Series (8 teaching hours or 2 weeks)	Aero_Std_1: Make sense of problems and persevere in solving them. Aero_Std_4: Model with mathematics.	IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts. IB_Obj_2: Problem-solving: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems.	Arithmetic sequences and series; sum of finite arithmetic series; geometric sequences and series; sum of finite and infinite geometric series. Sigma notation. Applications.	Students will be able to find the general term of a arithmetic (Or geometric) sequence, and also to calculate the sums of series.	Formative: Direct questioning in class, observation during class discussion, classwork, homework Summative: Test 1 (Objectives 1 2 and 3): two hours and calculator free. It will cover the 3 units of work	Mathematics HL (Core) Third Edition Chapter 7 Mathematics higher level Course Companion, Oxford
Permutations & Combinations (4 teaching hours or 1 week)	Aero_Std_1: Make sense of problems and persevere in solving them.	IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts.	Counting principles, permutations and combinations. The binomial theorem: expansion of $(a + b)n$, $n \in N$.	Students will know how to use the Counting Principle to solve Permutation and Combination problems. They will also know how to expand expressions using the binomial theorem.		Mathematics HL (Core) Third Edition Chapter 8
Mathematical Induction (4 teaching hours, Or 1 week)	3: Construct viable arguments and critique the reasoning of others. Aero_Std_3 8: Look for and express regularity in repeated reasoning.	IB_Obj_5: Reasoning: construct mathematical arguments through use of precise statements, logical deduction and inference, and by the manipulation of mathematical expressions. IB_Obj_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.	Proof by mathematical induction.	Students will learn how to prove mathematical statements using the principle of Mathematical induction		Mathematics HL (Core) Third Edition Chapter 9

Exponents and logarithms (8 teaching hours or 2 weeks)	Aero_Std_7: Look for and make use of structure. Aero_Std_5: Use appropriate tools strategically	IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts. IB_Obj_4: Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems.	Laws of exponents; laws of logarithms. Change of base. Solving exponential and logarithmic equations. Graphs of exponential and logarithmic functions.	Students will know how to use exponent laws to simplify expressions, how to solve exponential and logarithmic equations, and how to graph those equations using a calculator.	Formative: Direct questioning in class, observation during class discussion, classwork, homework Summative Test 2 (Objectives 1 and 2): 1 hour and will be Calculator free,	Mathematics HL (Core) Third Edition, Mathematics higher level Course Companion, Oxford
Function & Transformation (12 teaching hours or 3 weeks)	Aero_Std_7: Look for and make use of structure. 6: Attend to precision.	IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts. IB_Obj_4: Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems.	Concept of function; function notation. Domain, range. One-to-one & many-to-one functions. Odd and even functions. Composite functions Identity function. Modulus function Inverse function f−1, including domain restriction. Self-inverse functions. The graph of a function y = f (x) Investigation of key features of graphs, such as maximum and minimum values, intercepts, horizontal and vertical asymptotes and symmetry, and consideration of domain and range. The graph of y=1/f(x) given the graph of y = f (x). The rational function and its graph Transformations: translations; stretches; reflections in the axes.		Formative: Direct questioning in class, observation during class discussion, classwork, homework Test 3 (Objectives 1 and 2): 1 hour, and calculator allowed	Mathematics HL (Core) Third Edition Chapter 2 & 5

| | | | The graph of the inverse function as a reflection in y = x

Solutions of g(x) ≥ f (x) . Graphical or algebraic methods, for simple polynomials up to degree 3. Use of technology for these and other functions. | | | |
|---|---|---|---|---|---|---|
| Quadratic, Polynomial and complex number (part 1)

(8 teaching hours or 2 weeks) | Aero_Std_7: Look for and make use of structure.
Aero_Std_5: Use appropriate tools strategically | IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts.
IB_Obj_4: Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems. | Solving quadratic equations using the quadratic formula. Use of the discriminant $\Delta = b^2 - 4ac$ to determine the nature of the roots.

Polynomial functions and their graphs. The factor and remainder theorems. The fundamental theorem of algebra.

Solving polynomial equations both graphically and algebraically. Sum and product of the roots of polynomial equations.

Complex numbers: the terms real part, imaginary part, conjugate, modulus and argument. Cartesian form z = a + ib . Sums, products and quotients of complex numbers.

Conjugate roots of polynomial equations with real coefficients. (Polynomial theorem) | Students will be able to understand and work with complex numbers. They will also be able to solve most polynomial equations (Real and complex) algebraically and graphically | Formative: Direct questioning in class, observation during class discussion, classwork, homework
Summative Test 4 (Objectives 1 and 4): 2 hours, and calculator allowed | Mathematics HL (Core) Third Edition

Chapter 1 & 6 |
| Circular functions and trigonometry | Aero_Std_7: Look for and make use of structure. | IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, | The circle: radian measure of angles. Length of an arc; area of a sector. | Students will know how to calculate the arc length and find the area of a given sector. They will | Formative: Direct questioning in class, observation during class discussion, classwork, homework | Mathematics HL (Core) Third Edition |

(12 teaching hours or 3 weeks)	Aero_Std_5: Use appropriate tools strategically	concepts and techniques in a variety of familiar and unfamiliar contexts. IB_Obj_4: Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems.	Definition of cosθ , sinθ and tanθ in terms of the unit circle. Exact values of sin, cos and tan of some special angles and their multiples. Reciprocals: secθ , cscθ and cotθ . Basic identities: cos2θ + sin2θ =1; 1+ tan2θ = sec2θ ; 1+ cot2θ = csc2θ Compound angle identities. Double angle identities. Functions f (x) = asin(b(x + c)) + d Applications. Inverse functions arcsinx, arccosx, arctanx; domains, ranges; graphs. Algebraic and graphical methods of solving trigonometric equations in a finite interval, including the use of trigonometric identities and factorization. The cosine rule; The sine rule including the ambiguous case. Area of a triangle. Applications.	also know how to simplify trigonometric expressions, solve (Algebraically and graphically) trigonometric equations, and graph trigonometric equations.	Summative Test 5 (Objectives 1 and 4): 1 hour and will be Calculator free	Chapter 10, 11, 12 & 13
Complex number (part 2) (8 teaching hours or 2 weeks)		IB_Obj_1: Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts.	Modulus–argument (polar) form Euler's form. The ability to convert between forms is expected. The complex plane (Argand diagram)	Students will know how to represent a complex number on a Argand diagram, raise a complex number to a given power, and find the nth roots of a complex number	Formative: Direct questioning in class, observation during class discussion, classwork, homework Summative Test 6 (Objectives 1 and 2): 1 hour and will be Calculator free	Mathematics HL (Core) Third Edition Chapter 16

			Powers of complex numbers: de Moivre's theorem. nth roots of a complex number.		
Vector (16 teaching hours or 4 weeks)	Aero_Std_2: Reason abstractly and quantitatively.	IB_Obj_2: Problem-solving: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems.	Concept of a vector. Representation of vectors using directed line segments. Unit vectors; base vectors i, j, k. Components of a vector. Algebraic and geometric approaches to the following: • the sum and difference of 2 vectors; • the zero vector 0 , the vector −v ; • multiplication by a scalar, kv ; • magnitude of a vector, |v| ; • position vectors. The definition of the scalar product of two vectors. Properties of the scalar product. The angle between two vectors. Perpendicular vectors; parallel vectors. Vector equation of a line in two and three dimensions: r =a + λ b. Parametric form. Cartesian form. Simple applications to kinematics. The angle between two lines. Coincident, parallel, intersecting and skew lines; distinguishing between these cases. Points of intersection.	Students will be able to: Do the basic operations on vectors, determine whether vectors are parallel or perpendicular, find a vector perpendicular to 2 known vectors, find the angle between two vectors (Lines), find the different forms of the equation of a line, find the area of a parallelogram drawn from two intersecting vectors, find the volume of a parallelepiped drawn from 3 vectors, find the different types of the equation of a planes, find the intersection between a plane and a line, use vectors to solve real life problems	Formative: Direct questioning in class, observation during class discussion, classwork, homework Test 7 (Objectives 1 and 2): 2 hours and will be Calculator free	Mathematics HL (Core) Third Edition Chapter 14, 15

			The definition of the vector product of two vectors. Properties of the vector product. Geometric interpretation of v × w . Areas of triangles and parallelograms.
			
			Vector equation of a plane:
			  r = a +λb + μc
			Use of normal vector to obtain the form: r · n = a · n.
			Cartesian equation of a plane:
			  ax + by + cz = d
			
			Intersections of: a line with a plane; two planes; three planes.
			Angle between: a line and a plane; two planes.			

Differential Calculus (16 teaching hours or 4 weeks)	Aero_Std_2: Reason abstractly and quantitatively. Aero_Std_5: Use appropriate tools strategically	. IB_Obj_2: Problem-solving: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems. IB_Obj_4: Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems.	Limit, continuity and convergence. Definition of derivative from the first principles. The derivative interpreted as a gradient function and as a rate of change. Derivatives of xn , sinx , cosx , tanx , ex and lnx . Derivatives of sec x , csc x , cot x , ax , loga x , arcsin x , arccos x and arctan x . Product and quotient rules; chain rule. Implicit differentiation. The second and higher derivatives. Finding equations of tangents and normal; Identifying		Formative: Direct questioning in class, observation during class discussion, classwork, homework Summative Test 5 (Objectives 2 and 4): 1 hour and will be Calculator allowed	Mathematics HL (Core) Third Edition Chapter 17, 18, 19, 20

| | | | increasing and decreasing functions. Stationary points; Points of inflexion with zero and non-zero gradients. Graphical behavior of functions, including the relationship between the graphs of f , f′ and f " .

Local maximum and minimum values. Optimization problems. Related rates of change. | | | |
| Exploration (3 weeks) | 4: Model with mathematics | IB_Obj_2: Problem-solving: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems.

IB_Obj_6: Inquiry approaches: investigate unfamiliar situations, both abstract and real-world, involving organizing and analyzing information, making conjectures, drawing conclusions, and testing their validity. | Exploration criteria, examples and work to complete during summer holiday | Student will understand all the criteria and learn how to do an exploration and write the related report | IB Internal Assessement | |

Curriculum Map for Mathematics HL (DP2)

Unit Title (Time frame)	Standards	IB Objectives	Knowledge/Content	Skills	Assessments	Key resources
Integral Calculus (9-hour teaching + 2-hour test + 1-hour checking solution and summary. Therefore 12 hours in total or 3 weeks	Aero_Std_1	IB_Obj_1 IB_Obj_6	Indefinite integration as anti- differentiation. Indefinite integral of x^n , sin x , cosx and e^x . Other indefinite integrals The composites of any of these with a linear function.

Anti-differentiation with a boundary condition to determine the constant of integration. Definite integrals. Area of the region enclosed by a | Skills of finding the areas of irregular shapes. Skills of finding the volume of revolution about axes.

Skills of finding anti-derivatives by substitution method and integration by parts. | Test 1 (2 hours) | Mathematics HL (Core) Third Edition Chapter 21, 22 |

			curve and the *x*-axis or *y*-axis in a given interval; areas of regions enclosed by curves. Volumes of revolution about the *x*-axis or *y*-axis.			
Statistics and probability (15-hour teaching + 2-hour test + 1-hour checking solution and summary. Therefore 18 hours in total or 4.5 weeks if 4 classes per week)	Aero_Std_4	IB_Obj_2 IB_Obj_6	Concepts of population, sample, random sample and frequency distribution of discrete and continuous data. Grouped data: mid-interval values, interval width, upper and lower interval boundaries. Mean, variance, standard deviation. Concepts of trial, outcome, equally likely outcomes, sample space (U) and event. The probability of an event A as $P(A) = \frac{n(A)}{n(U)}$ The complementary events A and A' (not A). Use of Venn diagrams, tree diagrams, counting principles and tables of outcomes to solve problems. Combined events; the formula for P(A∪ B). Mutually exclusive events. 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 P(A∩ B) = P(A)P(B) to show independence. 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. Applications. Binomial distribution, its mean and variance. Poisson distribution, its mean and variance.	Basic skills of handling data by descriptive statistics. Skills of translate verbal language into probability notations and apply mathematical tools to solve it. Skills of creating distribution table for discrete random variable. Skills of handling probability density functions for continuous variables. Skills of modelling real life situations by binomial, Poisson and normal distributions.	Test 2 (2 hours)	Mathematics HL (Core) Third Edition Chapter 23, 24, 25, 26

			Normal distribution. Properties of the normal distribution. Standardization of normal variables.			
Option Calculus (21-hour teaching + 2-hour test + 1-hour checking solution and summary. Therefore 24 hours in total or 6 weeks if 4 classes per week)	Aero_Std_1	IB_Obj_1 IB_Obj_6	Infinite sequences of real numbers and their convergence or divergence. Convergence of infinite series. Tests for convergence: comparison test; limit comparison test; ratio test; integral test. The *p*-series, $\sum_1^\infty \frac{1}{n^p}$ Series that converge absolutely. Series that converge conditionally. Alternating series. Power series: radius of convergence and interval of convergence. Determination of the radius of convergence by the ratio test. Continuous functions and differentiable functions. The integral as a limit of a sum; lower and upper Riemann sums. Fundamental theorem of calculus. Improper integrals of the type: $$\int_a^\infty f(x)dx$$ First-order differential equations. Geometric interpretation using slope fields, including identification of isoclines. Numerical solution of. $$\frac{dy}{dx} = f(x, y)$$ using Euler's method. Variables separable. Homogeneous differential equation	Skills of applying relevant rules, tests and theorems to convergent and divergent issues involving limits, infinite sequences and series. Skills of solving first-order differential equations of typical types. Skills of performing Taylor and Maclaurin expansions and handling error terms.	Test 3 (2 hours)	Mathematics HL (Option) Calcuus

$$\frac{dy}{dx} = f(\frac{y}{x})$$

using the substitution y = vx.
Solution of y'+ P(x)y = Q(x), using the integrating factor.

Rolle's theorem. Mean value theorem.

Taylor polynomials; the Lagrange form of the error term.

Maclaurin series for e^x , sin x , cos x ,
ln(1+ x) , (1+ x)^p , p∈Q .

Use of substitution, products, integration and differentiation to obtain other series. Taylor series developed from differential equations.

The evaluation of limits of the form
$$\lim_{x \to a}\frac{f(x)}{g(x)} \;\; and \;\; \lim_{x \to \infty}\frac{f(x)}{g(x)}$$

The indeterminate forms $\frac{0}{0} \; and \; \infty/\infty$

Using l'Hôpital's rule or the Taylor series.