A level Further Mathematics Curriculum Overview (Year 12)

Introduction
This curriculum broadly follows the order of the Edexcel textbook except: - In Core 1, Volumes of Revolution is covered last to ensure integration has been seen in A level Mathematics - Majority of students take options FP1 and D1, in that order. - In Term 3 time is spent covering calculus techniques required early in Year 13 (before they would be taught in A level Mathematics) **Edexcel specification:** https://qualifications.pearson.com/en/qualifications/edexcel-a-levels/mathematics-2017.html#%2Ftab-AlevelFurtherMathematics **Extension links** UKMT senior challenge (https://ukmt.org.uk/senior-challenges) MAT (https://www.maths.ox.ac.uk/study-here/undergraduate-study/maths-admissions-test) STEP modules (https://maths.org/step/assignments)

Term 1 Half Term 1				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Complex numbers Argand diagrams Series	**Knowledge**: Understand the real and imaginary parts of a complex number a+bi Understand and manipulate complex numbers Find complex solutions to quadratic equations Find complex solutions to cubic and quartic equations Represent complex numbers on an Argand diagram Put a complex number in modulus-argument form Identify loci and regions Maximise and minimise the modulus and argument of z Recall and use series notation Find the sum of the first n natural numbers Break up summations in order to evaluate them more easily **Understanding:** Complex roots of polynomials with real coefficients come in conjugate pairs. **Skills:** Calculations with complex numbers Algebraic manipulation Apply the formulae for the sum of the first n integers, first n square numbers and first n cube numbers	**Formal homeworks:** Chapter 1 Assessment Chapter 1-2 Assessment Chapter 3 Assessment	Edexcel Core 1 Textbook Note: GCSE Higher – Rationalising a denominator Factorising a quadratic equation Loci Co-ordinate geometry – gradient, parallel and perpendicular lines, circle geometry, perpendicular bisectors Pythagoras Theorem Dividing complex numbers using conjugates is comparable to dealing with surds at GCSE and covered in 12 Maths Aut 1 also.	Scheme of Learning – guidance on key learning points and selected questions for each individual lesson Outline PowerPoints with suggested examples and scaffolding activities Practice questions (and markschemes) covering topics using previous exam questions available for each chapter via SharePoint. For extension: UKMT senior challenge, MAT and STEP Foundation materials Online resource: https://sites.google.com/view/tlmaths/home/a-level-further-maths

Term 1 Half Term 2				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Roots of polynomials Matrices and linear transformations	**Knowledge**: Derive and use the relationship between the roots of quadratic, cubic and quartic equations. Evaluate expressions relating to the roots of polynomials. Understand the concept of a matrix, define zero and identity matrices, multiply as matrix by a scalar, multiply matrices, calculate the determinant of a matrix, transpose a matrix. **Understanding:** Find the equation of a polynomial whose roots are a linear transformation of the roots of a given polynomial. Use and derive expressions relating to reciprocals and products of powers. Find the inverse of a matrix, use matrices to solve equations, interpret simultaneous equations geometrically. Represent linear transformations using matrices. Understand the connection between the determinant and the scale factor for the change of area in an enlargement. Perform successive transformations using matrices. Perform linear transformations in 3 dimensions **Skills:** Expanding polynomials, factorising expressions, algebraic manipulation, model real situations using matrices, write down the matrix representing a rotation about any angle.	**Formal homeworks:** Chapter 4 Assessment Chapter 6-7 Assessment **Exam conditions:** Chapter 1-4 Test	Edexcel Core 1 Textbook Note: Students will need to use the fact that roots of polynomials with real coefficients come in conjugate pairs and to be able to Illustrate roots on an argand diagram from Term1 half term 1. Knowledge of GCSE transformations, trigonometry, and Pythagoras.	Scheme of Learning – guidance on key learning points and selected questions for each individual lesson Outline PowerPoints with suggested examples and scaffolding activities Practice questions (and markschemes) covering topics using previous exam questions available for each chapter via SharePoint. For extension: UKMT senior challenge, MAT and STEP Foundation materials Online resource: https://sites.google.com/view/tlmaths/home/a-level-further-maths

Term 2 Half Term 1				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Proof by induction Vectors and scalar product Volumes of revolution	**Knowledge**: Vectors – representation, magnitude, position and direction, problem solving and modelling. Differentiation. Integration. Exponentials, logarithms, the natural logarithm, nonlinear data. **Understanding:** To understand column vectors and unit vectors i and j. Using vectors to find velocity, displacement, and force. Increasing and decreasing functions, stationary points and second derivatives. Differentiation from first principles. Definite integrals, area under a curve, area between curve and straight lines. $y=e^{x,}$ the law of logarithms. Logarithms as inverse of exponential. **Skills:** Using Pythagoras and trigonometry to find magnitude and direction form. Manipulating functions and sketching gradient functions, applying knowledge to problems, recognise how to solve the area under graphs and between curves and straight lines. Solving equations using logs, plotting graphs using logs.	**Formal homeworks:** Chapter 8 Assessment Chapter 9 Assessment Chapter 5 Assessment **Exam conditions:** Y12 Jan Mock (full Core 1 Paper)	Edexcel Core 1 Textbook Note: Term 1 A level Maths sequence notation for proofs Rules of indices GCSE and half term 1 foundations of A level Matrices work from half term 2 Further Maths Vectors in 2D covered at GCSE and taken further in Maths A level in Term 2 Half term 1 (likely covered here first) Integration concepts Term 1 Maths A level but will need to cover definite integration here.	Scheme of Learning – guidance on key learning points and selected questions for each individual lesson Outline PowerPoints with suggested examples and scaffolding activities Practice questions (and markschemes) covering topics using previous exam questions available for each chapter via SharePoint. For extension: UKMT senior challenge, MAT and STEP Foundation materials Online resource: https://sites.google.com/view/tlmaths/home/a-level-further-maths

Term 2 Half Term 2				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Further Pure: Vectors (vector product), Conic sections (parabolas and rectangular hyperbolas), Inequalities t-formulae Numerical methods to solving differential equations	**Knowledge**: Definition of vector product and ways to calculate it. Use of parametric equations. Equations of parabolas and rectangular hyperbolas. Foci and directrices. Effect on inequalities when multiplying by a possible negative value, and to use squaring to avoid this. New trigonometric functions sec, cosec, cot. The t-formulae. Euler's formulae for approximating solutions to first- and second-order differential equations. The midpoint formulae for approximating solutions to first-order differential equations. **Understanding:** Cyclical nature of the scalar triple product. Loci resulting from points from conic sections. Properties of focus and directrix for a parabola. Selecting and manipulating the appropriate formula to approximate solutions to differential equations. **Skills:** Using vector product to calculate areas and volumes. Be able to calculate tangents and normal to conic sections. Using graphs to solve inequalities. Solve equations and prove identities using the t-formulae. Find approximate solutions to differential equations using numerical methods.	**Formal homeworks:** Chapter 1 Assessment Chapter 2 Assessment Chapter 4 Assessment Chapter 5 Assessment Chapter 8 Assessment	Edexcel Further Pure 1 Textbook Note: Related topics in GCSE Higher include: Vectors Drawing graphs of polynomials Inequalities Trigonometry The vectors work in Ch1 builds directly on the work from Pure1 Ch11 (Maths - Spring 1) and Core1 Ch9 (Spring 1). Finding tangents and normals through differentiation is seen in Pure1 Ch12 (Maths – Spring 1)	Scheme of Learning – guidance on key learning points and selected questions for each individual lesson Outline PowerPoints with suggested examples and scaffolding activities Practice questions (and markschemes) covering topics using previous exam questions available for each chapter via SharePoint. For extension: UKMT senior challenge, MAT and STEP Foundation materials Online resource: https://sites.google.com/view/tlmaths/home/a-level-further-maths

Term 3 Half Term 1				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Decision Mathematics: Algorithms (sorting, bin-packing, order of, Prim's, Kruskal's, Dijkstra's, route inspection) Linear programming Critical path analysis	**Knowledge**: Bubble sort, quick sort and the three bin-packing algorithms. Terminology used in graph theory. Kruskal's and Prim's algorithms. Dijkstra's algorithm. Route inspection algorithm. Formulations of a linear programming problem. Precedence tables. Identify and know how to calculate early and late event times, identify critical values and calculate the total float of an activity. Gantt charts **Understanding:** Use and understand algorithms given in words and flow charts. Understand the strengths and limitations of different sorting methods. Understand when a linear programming problem requires integer solutions. **Skills:** Setting up and solving simultaneous equations. Use matrices to represent graphs and networks. Determine whether a graph is Eulerian, semi-Eulerian or neither using the order of nodes. Illustrate a two-variable linear programming problem graphically. Determine a feasible region and locate an optimal point using an objective line or vertex testing.	**Formal homeworks:** Chapter 1-2 Assessment Chapter 3-4 Assessment Chapter 6 Assessment Chapter8 Assessment	Edexcel Decision Mathematics 1 Textbook Note: Related topics in GCSE Higher include: Solving inequalities Graphing inequalities Shading feasible regions Setting up and solving simultaneous equations Computer Science students will be familiar with the idea of algorithms and 'trace tables' as used in Ch1.	Scheme of Learning – guidance on key learning points and selected questions for each individual lesson Outline PowerPoints with suggested examples and scaffolding activities Practice questions (and markschemes) covering topics using previous exam questions available for each chapter via SharePoint. For extension: UKMT senior challenge, MAT and STEP Foundation materials Online resource: https://sites.google.com/view/tlmaths/home/a-level-further-maths

Term 3 Half Term 2				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Advanced techniques in calculus (in preparation for Core 2)	**Knowledge**: Differentiation techniques: chain rule, product rule, quotient rule. Derivatives of exponentials, logarithms, trigonometric functions, and combinations of these. Format of partial fractions for denominators with linear and repeated factors. Implicit differentiation. Integration techniques: reversing the chain rule, using standard patterns, using partial fractions, substitution, by parts. **Understanding:** When to use different calculus methods (eg chain rule vs product rule). Link of implicit differentiation to the chain rule. Link of integration by parts to the product rule. Link of partial fractions to 'reversing' addition of fractions. **Skills:** Be able to differentiate and integrate a much wider range of expressions. Be able to decompose a fraction into partial fractions, using algebraic division if necessary. Be able to use trigonometric identities to manipulate integrands into formats ready for integration.	**Formal homeworks:** Chapter 1 Assessment Chapter 2 Assessment **Exam conditions:** End of Y12 Mock (full set of papers)	Old Edexcel C3 and C4 Textbooks Note: The differentiation work builds directly on techniques in Pure 1 Ch12 (Maths – Spring 1). The integration work builds directly on techniques in Pure 1 Ch13 (Maths – Spring 1) Partial fractions may have already been taught in (Maths – Summer 2) and only need revision. Use of trigonometric identities builds on Pure 1 Ch10 (Maths – Autumn 2) but also the newer trigonometric ratios seen in FP1 Ch5 (Summer 1)	Scheme of Learning – guidance on key learning points and selected questions for each individual lesson Outline PowerPoints with suggested examples and scaffolding activities Practice questions (and markschemes) covering topics using previous exam questions available for each chapter via SharePoint. For extension: UKMT senior challenge, MAT and STEP Foundation materials Online resource: https://sites.google.com/view/tlmaths/home/a-level-further-maths