On – Line Programme of Learning for Year 13 – Further Mathematics

Autumn		Spring		Summer	
From: September	To: December	From: January	To: April	From: May	To: July
Teacher 1: **Topic – A2 Pure Maths** **Integration** **Topic: - Core Pure 2** Series Methods in Calculus Methods in Differential Equations **Topic – Further Pure 1** Vectors Inequalities The t-formulae	**Teacher 2:** **Topic: - Core Pure 2** Complex Numbers Volumes of Revolution Polar Coordinates Hyperbolic Functions	**Teacher 1:** **Topic: - Core Pure 2** Modelling with Differential Equations **Topic – Further Pure 1** Conic Sections Taylor Series Methods in Calculus Numerical Methods Reducible Differential Equations	**Teacher 2:** **Topic – Further Mechanics 1** Momentum and Impulse Elastic Strings and Springs Elastic Collisions in two-dimensions	**Revision for exams** **External exams will be sat this term.**	
Key Skills – A2 Pure Maths Integrate standard mathematical functions including trigonometric and exponential functions and use the reverse of the chain rule to integrate functions of the form f(ax + b) Use trigonometric identities in integration Use the reverse of the chain rule to integrate more complex functions Integrate functions by making a substitution, using integration by parts and using partial fractions Differentiate and integrate parametric equations **Key Skills – CP2** Understand and use the method of differences to sum finite series Find and use higher derivatives of functions.	**Key Skills – CP2** Express a complex number in exponential form. Multiply and divide complex numbers in exponential form. Understand de Moivres's theorem. Use de Moivres's theorem to derive trigonometric identities; find sums of series; and to find the nth root of equations. Use complex roots of unity to solve geometric problems. Find volumes of revolution around both the x- and y-axis and for curves defined parametrically. Model real-life applications of volumes of revolution. Understand and use polar coordinates. Convert between polar and Cartesian coordinates Sketch polar curves.	**Key Skills – CP2** Model real-life situations with first-order differential equations. Use differential equations to model simple harmonic motion. Model damped and forced oscillations using differential equations. Model real-life situations using coupled first-order differential equations. **Key Skills – FP1** Identify an ellipse or a hyperbola from its Cartesian or parametric equations. Find the foci, directrices, and eccentricity for an ellipse or a hyperbola. Find tangents and normal to ellipse and hyperbolae. Solve simple loci questions. Derive and use Taylor series for simple functions.	**Key Skills – FM1** Use the impulse-momentum principle and the principle of conservation of momentum in vector form. Use Hooke's law to solve equilibrium problems involving elastic strings or springs. Use Hooke's law to solve dynamics problems involving elastic strings or springs. Find the energy stored in an elastic string or spring. Solve problems involving elastic energy using the principle of conservation of mechanical energy and the work-energy principle. Solve problems involving the oblique impact of a smooth sphere with a fixed surface. Solve problems involving the oblique impact of two smooth spheres.		

Know how to express functions as an infinite series in ascending powers using Maclaurin series expansion Bea bale to find the series expansions of compound functions. Evaluate improper integrals Understand and evaluate the mean value of a function. Integrate rational functions using trigonometric substitutions Integrate using partial fractions. Solve first-order differential equations using an integrating factor. Solve second-order homogeneous differential equations using the auxiliary equation. Solve second-order non-homogeneous differential equations using the complimentary function and the particular integral. Find particular solutions to differential equations using given boundary conditions. **Key Skills – FP1** Write the vector equation of a line using the cross product. Find the direction rations and direction cosines of a line. Use vectors in problems involving points, lines and planes Use the equivalent Cartesian forms for the equations of lines and planes. Solve inequalities involving modulus signs	Find the area enclosed by a polar curve. Find tangents parallel to, or at right angles to, the initial line. Understand the definitions of hyperbolic functions Sketch the graphs of hyperbolic functions. Understand and use the inverse hyperbolic functions. Prove identities and solve equations using hyperbolic functions. Differentiate and integrate hyperbolic functions. Polar coordinates and hyperbolic functions introduce new functions and graphs – linking to previous skills in coordinate geometry and trigonometry.	Use series expansions to evaluate limits. Use the Taylor series method to find a series solution to a differential equation. Apply Leibnitz's theorem for differentiating products Understand the use of derivatives to evaluate limits of indeterminate forms using l'Hospital's rule. Use tangent half-angle substitutions to find definite and indefinite integrals using Weierstrass substitution. Find numerical solutions to first-order differential equations using Euler's method and the mid-point method. Extend Euler's method to find numerical solutions to second-order differential equations. Use Simpson's rule to find an approximation for a given definite integral. Use a substitution to transform first and second-order differential equations into ones that can be solved. Solve modelling problems involving reducible differential equations.	Solve problems involving successive oblique impacts of a sphere with smooth plane surfaces.		

Use the t-formulae for modelling with trigonometry.					
Assessments: At AS students will be assessed on their ability to A01 (50%): Use and apply standard techniques – i.e. be able to (i) select and carry out routine procedures; (ii) accurately recall facts, terminology and definitions A02 (at least 15%): Reason, interpret and communicate mathematically – i.e. be able to (i) construct rigorous mathematical arguments (including proofs); (ii) make deductions and inferences; (iii) assess the validity or mathematical arguments; (iv) explain their reasoning; (v) use mathematical language and notation correctly A03 (at least 15%): Solve problems within mathematics and in other contexts – i.e. be able to (i) translate problems in mathematical and non-mathematical contexts into mathematical processes; (ii) interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations; (iii) translate situations in context into mathematical models; (iv) use mathematical models; (v) evaluate the outcome of modelling in context. Recognise the limitations of models and, where appropriate, explain how to refine them.					
End of term 1 assessment to cover: All AS content will be assessed in September All A2 content taught in Autumn 1 will be assessed in November.		**Term 2 assessment to cover:** January exams will assess AS content for FP! And FM1 and all Core Pure content covered in year 12 and the autumn term.			
Building understanding: Rationale / breakdown for your sequence of lessons: The key topics in Year 2 Mathematics have to be complete before any progress can be made in Core Pure. The topic of series builds on the CP1 topic and on fluency in year 2 differentiation. Methods in Calculus relies on fluency in year 2 integration. Differential equations are introduced this term – building on A2 skills and laying the foundation for the rest of the course. Moving on to FP1 topics then gives time for further practice and consolidation of calculus skills before tacking differential equations. For FP1, the topics covered this term all extend the equivalent AS topics and have no reliance on calculus skills.	**Building understanding: Rationale / breakdown for your sequence of lessons:** Complex numbers builds on the skills learnt at AS on this topic. Volumes of revolution looks at more complex models and utilises integration skills covered in A2 mathematics.	**Building understanding: Rationale / breakdown for your sequence of lessons:** Conic Sections builds on the AS content and utilises hyperbolic functions taught last term. The remainder of the term takes a sequential approach through differential equations building on the foundations laid last term. Some further methods in calculus are introduced to extend the calculus skills and we cover numerical methods. The topics covered rely heavily on fluency in all algebra and calculus skills covered on the course to date.	**Building understanding: Rationale / breakdown for your sequence of lessons:** This term takes students through the final topics in further mechanics – building on skills learnt at AS. The mechanics teacher is likely to finish teaching early in the term and will move onto revision of key topics.	

Whilst students haven't yet covered modulus function in A2 mathematics, the further mathematicians have enough knowledge of graphs for this to not be an issue within inequalities.					
Calendared Centrally Planned Extended Home – Learning Tasks: End of chapter assessments will take place regularly in lessons					
Reading / literacy / Oracy: For reading in mathematics, see the links under enrichment. For literacy, students will learn how to break down long worded problems to extract the mathematics involved. This will be modelled in the classroom. Students should get used to reading all parts of the textbook / exam questions and challenging words they don't understand.					
Numeracy: Students should be numerate in terms of knowing what a sensible answer looks like for any question they answer and not simply relying on the calculator.					
Enrichment / opportunities to develop cultural capital (including careers, WRL and SMSC): Plus Magazine https://plus.maths.org/content/– an online magazine that provides articles and podcasts for all aspects of mathematics, often discussing aspects of mathematics underlying recent news stories. They regularly interview people in maths-based careers and so this is a great source of inspiration for real world mathematics. Imperial College run an on-line programme (including masterclasses and MOOCs) in the spring and summer term for students in year 12 who are considering mathematics at university and aiming for an A* - https://www.imperial.ac.uk/be-inspired/schools-outreach/secondary-schools/mentoring-and-tutoring/maths-online-programme/ The practice materials for university admissions provide enrichment and challenge on AS topics for students aspiring to the top grades. TMUA is the most accessible. https://www.admissionstesting.org/for-test-takers/test-of-mathematics-for-university-admission/preparation/ ; whilst the Oxford MAT papers are more challenging https://www.maths.ox.ac.uk/study-here/undergraduate-study/maths-admissions-test/mat-past-papers A padlet of resources for enrichment and revision for Featherstone students is kept here https://padlet.com/lemerson3/KS5maths					