Year 12 Further Maths Curriculum Map

Sequencing of topics	**What knowledge will students develop? (Including key terminology)**	**What skills will students develop? (Including literacy & numeracy)**	**Assessment opportunities**	**Homework opportunities**	**Personal development (Ursuline Values, Catholic Social Teaching, Cultural Capital, Cross-curricular, Careers)**	**Curriculum Links**
Autumn Term						
Complex numbers (part 1)	• Introduction of complex numbers • basic manipulation • Argand diagrams • Modulus and argument Loci	• be able to solve any quadratic equation with real coefficients; • be able to add, subtract and multiply complex numbers in the form x + iy with x and y real; • understand and use the terms 'real part' and 'imaginary part'. • be able to use and interpret Argand diagrams. • be able to convert between the Cartesian form and the modulus-argument form of a complex number; • be able to multiply and divide complex numbers in modulus-argument form. • be able to construct and interpret simple loci in the Argand diagram such as $\|z - a\| > r$ and $\arg(z - a) = \theta$. •	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **United in Harmony**: Teaching complex numbers emphasizes the interconnectedness of real and imaginary components. By exploring the unity and harmony of these components, students can develop a deeper appreciation for the beauty and elegance of complex numbers. • Call to Family, Community, and Participation • Solidarity • Access to online math communities or forums that focus on complex number discussions and problem-solving. • Physics • Computer Science • Electrical engineer	Quadratics Equations and inequalities

Year 12 Further Maths Curriculum Map

					• Control systems engineer • Mathematician • Physicist • Software developer	
Matrices	• Matrix addition, subtraction and multiplication • Inverse of 2×2 and 3×3 matrices • Simultaneous equations Linear transformations	• be able to calculate determinants of 2×2 and 3×3 matrices; • understand and use singular and non-singular matrices; • be able to know the properties of inverse matrices; • be able to calculate the inverse of non-singular 2×2 and 3×3 matrices. • be able to use matrices and their inverses to solve linear simultaneous equations, including three linear simultaneous equations in three variables; • be able to interpret geometrically the solution and failure of solution of three simultaneous linear equations. • be able to use matrices to represent 2D rotations, reflections, enlargements and translations; • understand and use zero and identity matrices; • be able to use matrix products to represent combinations of transformations;	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **United in Harmony**: Matrices provide a unified framework for solving systems of equations and representing transformations, promoting harmony in mathematical understanding. • Human Dignity • Common Good • Exposure to real-world examples and applications of matrices through field trips or guest speakers. • computer science • physics • economics. • Data Analyst • Statistician • Computer Programmer	

		• be able to use matrices to represent linear transformations in three dimensions; • be able to use inverse matrices to reverse the effect of a linear transformation; • be able to use the determinant of a matrix to determine the area scale factor of a transformation; • be able to find invariant points and lines for a linear transformation. •				
Complex numbers (part 2)	Complex conjugate, division and solving polynomial equations	• understand and use the complex conjugate of a complex number; • be able to divide two complex numbers by using the complex conjugate of the denominator; • know that non-real roots of polynomial equations with real coefficients occur in conjugate pairs; • be able to solve cubic or quartic equations with real coefficients. •	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **United in Harmony**: Teaching complex numbers emphasizes the interconnectedness of real and imaginary components. By exploring the unity and harmony of these components, students can develop a deeper appreciation for the beauty and elegance of complex numbers. • Call to Family, Community, and Participation • Solidarity	Complex numbers (part 1)

Year 12 Further Maths Curriculum Map

					• Exposure to diverse cultural contexts and perspectives in relation to complex number systems and their historical development • Physics • Computer Science • Electrical engineer • Control systems engineer • Mathematician • Physicist • Software developer	
Series	Sums of series	• be able to use sigma notation; • understand and use formulae for the sums of integers, squares and cubes; • be able to use known formulae to sum more complex series. •	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **Grateful and Generous:** By studying and understanding various types of series, students can appreciate the beauty and richness of mathematical patterns and sequences. Students can also apply the concept of series in practical contexts, such as financial planning or analyzing real-world data, fostering a spirit of generosity in making informed	Quadratics Equations and inequalities

Year 12 Further Maths Curriculum Map

					decisions and sharing their insights with others. • Solidarity • Option for the Poor • Attendance at math conferences or workshops that discuss series convergence and divergence. • Physics • Financial analyst • Actuary • Mathematician	
Algebra and functions	• Roots of polynomial equations Formation of polynomial equations	• understand and use the relationship between roots and coefficients of polynomial equations up to quartic equations. • be able to form a polynomial equation whose roots are a linear transformation of the roots of a given polynomial equation (of at least cubic degree). •	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **Discerning and Joyful**: By exploring the roots of polynomials, students develop their ability to analyse and discern mathematical patterns, fostering a discerning mindset. • Human Dignity • Common Good • Access to supplementary materials or textbooks that offer alternative explanations and problem-solving strategies. • Physics • computer science	Quadratics Equations and inequalities Binomial expansion

Year 12 Further Maths Curriculum Map

					• Aerospace engineer, cryptographer, mathematical modeler	
Proof	Proof by mathematical induction	• be able to obtain a proof for the summation of a series, using induction; • be able to use proof by induction to prove that an expression is divisible by a certain integer; • be able to use mathematical induction to prove general statements involving matrix multiplication. •	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **Courageous and Resilient** • Induction proofs often involve demonstrating a statement holds true for all-natural numbers by establishing a base case and employing an inductive step. This process may involve working with unfamiliar or challenging concepts and requiring persistence and resilience in overcoming obstacles. • Truth and Integrity • Exposure to mathematical journals or articles that showcase proofs by induction. • Computer science • Physics • Software developer mathematician • research scientist	Series Matrices
Spring Term						

Year 12 Further Maths Curriculum Map

Vectors	• Vector and Cartesian equations of a line and a plane • Scalar product Problems involving points, lines and planes	• know how to find the vector equation of a line in both two and three dimensions; • understand and use the Cartesian forms of an equation of a straight line in three dimensions; • understand and use the vector and Cartesian forms of the equation of a plane. • be able to find the scalar product of two vectors; • be able to check whether vectors are perpendicular by using the scalar product; • be able to use the scalar product to express the equation of a plane; • be able to use the scalar product to calculate the angle between two lines; • be able to use the scalar product to calculate the angle between two planes; • be able to use the scalar product to calculate the angle between a line and a plane. • be able to find the points of intersection of lines and planes which meet; • be able to calculate the perpendicular distance between two lines;	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **United in Harmony** • By learning about vectors, students understand how different components or forces can come together to create a unified result. This value emphasizes the importance of collaboration, teamwork, and recognizing the interconnectedness of various elements. • Option for the Poor • Participation in STEM camps or workshops that focus on spatial reasoning and geometry. • Physics • Computer science • Architect • Civil engineer • video game designer	

		• be able to calculate the perpendicular distance from a point to a line or to a plane. •				
Calculus	Volumes of revolution	• be able to derive formulae for and calculate volumes of revolution about both the x and y-axes.	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **United in Harmony** • the volume of revolution brings together geometry and calculus. Students can develop an appreciation for the unity and harmony in mathematics and recognize the beauty in seeing diverse mathematical ideas come together. • Grateful and Generous • Access to 3D modelling software or virtual reality tools that allow students to visualize volumes of revolution. • Physics • Structural engineer • industrial designer • mathematician	Calculus
Momentum and impulse (part 1)	• Momentum and impulse; derivation of units and formulae	• understand the definitions, derivation, and units of momentum and impulse; • understand what happens to the momentum of a sphere as a result of a collision;	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos	• **Leading for Justice** • Students can explore how the principles of conservation of momentum and impulse align with the	Kinematics

	• Impulse-momentum principle. Conservation of momentum applied to collisions and 'jerking' string problems	• be able to use the principle of conservation of momentum applied to direct collisions in 1-dimension. •		2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	pursuit of justice and truth, as these concepts provide a foundation for understanding the dynamics of interactions and the equality of action and reaction. • Human Dignity • Common Good • Having access to mentors or coaches who can provide guidance and support in understanding and applying principles of momentum and impulse. • Physics • Physical Education • Mechanical engineer • Sports scientist • Automotive engineer	
Work, energy and power	• Work, kinetic energy; derivation of units and formulae • Potential energy, work-energy principle, conservation of	• understand the derivation, units and definitions of work and energy; • be able to define kinetic energy (KE); • understand that work done on a body moving in a horizontal plane is the change in kinetic energy.	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions	• **Leading for Justice** • students can critically analyse energy-related issues, such as access to energy resources, environmental sustainability, and social equity. They can become informed	Kinematics

	mechanical energy, problem solving Power; derivation of units and formula	• understand the concept of gravitational potential energy (GPE); • be able to include GPE when applying the work-energy principle; • know the conditions for conservation of mechanical energy; • be able to solve problems involving work and energy. • understand that power in watts is the rate of doing work; • be able to calculate the power (P) of a vehicle with a tractive (driving) force F, moving with velocity v; • be able to use the formula P = Fv in problem solving. •		3. Past exam questions 4. Opportunities for flipped learning	advocates for responsible energy practices and strive for a more just and sustainable world. • Solidarity • Option for the Poor and Vulnerable • Access to educational resources such as books, online tutorials, or workshops that enhance understanding of work, energy, and power concepts. • Physics • Design & Technology • Renewable energy engineer • Environmental scientist • Electrical engineer	
Elastic collisions in one dimension	• Direct impact of elastic spheres. Newton's law of restitution. Loss of kinetic energy due to impact Problem solving (including 'successive' impacts)	• be able to express the 'compressibility', 'bounciness' or 'elasticity' of an object by a value called the coefficient of restitution (e); • know that $\mathbf{0} \leq \boldsymbol{e} \leq \mathbf{1}$ [and that e = 0 means inelastic and e =1 means perfectly elastic]; • know and be able to use Newton's (experimental) law	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions	• **Leading for Justice, Truth, and Integrity** • an opportunity to discuss the importance of justice, truth, and integrity in physics and related fields. Students can explore how the conservation laws,	

		of restitution for direct impacts of elastic spheres; • be able to calculate the change in kinetic energy due to an impact. • be able to solve problems of the following types involving elastic impacts: • successive collisions between pairs of spheres (horizontal motion); • bouncing ball (off a horizontal elastic plane); • successive collisions including two spheres and sphere against a wall; • determination of number of collisions or deriving the possible range of e. •		3. Past exam questions 4. Opportunities for flipped learning	such as conservation of momentum and kinetic energy, align with the pursuit of justice and truth. • Subsidiarity • Stewardship of Creation • Exposure to scientific museums or exhibits that showcase principles of elastic collisions. • Physics • Astrophysicist • Aerospace engineer • Crash test engineer	
Momentum and impulse	• Momentum as a vector (i, j problems) Impulse-momentum principle in vector form	• be able to extend the definition of linear momentum and impulse to 2-D using vectors. • be able to use the impulse-momentum principle in vector form i.e. I = mv – mu. •	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for	• **Leading for Justice** • Students can explore how the principles of conservation of momentum and impulse align with the pursuit of justice and truth, as these concepts provide a foundation for understanding the dynamics of interactions and the	

				flipped learning	equality of action and reaction. • Human Dignity • Common Good • Having access to mentors or coaches who can provide guidance and support in understanding and applying principles of momentum and impulse. • Physics • Physical Education • Mechanical engineer • Sports scientist • Automotive engineer	
Elastic strings and springs and elastic energy	• Hooke's law and definition of modulus of elasticity. Derivation of elastic potential energy formula. Problem solving: equilibrium and using the work-energy principle	• be able to investigate the ability of strings to stretch and springs to stretch and compress; • be able to define the modulus of elasticity (λ), natural length (a) and extension (x); • be able to use the above definitions to work out the tension in a stretched string or a stretched/compressed spring i.e. use Hooke's Law, $T = \frac{\lambda x}{a}$; • be able to derive the elastic potential energy (EPE) from Hooke's Law by applying the	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **Discerning and Joyful** • Hooke's law encourages students to discern patterns and relationships between applied forces and resulting displacements in elastic materials. • Care for God's Creation • Option for the Poor and Vulnerable • Visiting science museums or exhibitions: Museums often have interactive	

		work done in stretching a string/spring . i.e. EPE = $\frac{\lambda x^2}{2a}$. • be able to calculate the tension in a string or spring when a system is held in equilibrium; • be able to include EPE when using the work-energy principle; • know the conditions for conservation of mechanical energy; • be able to solve string/spring problems involving work and energy (i.e. KE, GPE and EPE).			exhibits that demonstrate the principles of Hooke's law. Visitors can engage with displays showcasing springs, rubber bands, or other elastic materials and observe the relationship between force and displacement. • Physics • Design & Technology • Materials engineer • Civil engineer • Product designer	
Summer Terms						
Elastic collisions in two dimensions	• Oblique impact of a smooth sphere with a fixed surface • Successive oblique impacts of a sphere with smooth plane surfaces Oblique impact of two smooth spheres of equal radius	• understand that during an impact the impulse acts perpendicularly to the surface through the centre of the sphere; • be able to apply Newton's (experimental) law of restitution in the direction of the impulse; • appreciate that perpendicular to the impulse, the velocity component does not change; • understand and be able to calculate an angle of deflection;	End of topic assessment	Textbook/Practice Book/Other online resources These include: 1. Videos 2. Practice questions 3. Past exam questions 4. Opportunities for flipped learning	• **Leading for Justice, Truth, and Integrity** • an opportunity to discuss the importance of justice, truth, and integrity in physics and related fields. Students can explore how the conservation laws, such as conservation of momentum and kinetic energy, align with the pursuit of justice and truth. • Solidarity	

		• be able to calculate the kinetic energy 'lost' in an impact; • be able to work in speeds and angles or in velocity vectors (i, j). • understand that, during a collision between two smooth spheres, total momentum is conserved and the impulse acts in the direction of the line of centres; • be able to apply Newton's (experimental) law of restitution in the direction of the line of centres; • appreciate that perpendicular to the line of centres, velocity components do not change; • understand and be able to calculate an angle of deflection; • be able to calculate the kinetic energy 'lost' in a collision; • be able to work in speeds and angles or in velocity vectors (i, j).			• Common Good • Access to virtual simulations or computer programs that allow exploration and visualization of two-dimensional elastic collisions. • Physics • Robotics engineer • Computer game developer • Biomechanical engineer	