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אל תקרי בניך אלא בוניך

SUBJECT CURRICULUM PLAN

SUBJECT:	Mathematics (Further)	**YEAR GROUP:**	**12**
SUBJECT INTENT:	To master advanced algebraic foundations, multi-dimensional matrix operations, discrete statistical models, and Newtonian particle mechanics, providing a seamless bridge to A-Level Core Pure systems.		

TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Autumn	Pure 1: Algebraic Methods	Dividing polynomials using grid or long division methods; applying the Factor Theorem and Remainder Theorem to completely factor cubic expressions.	Polynomial quotient, remainder constraints, polynomial factors.	Extends Year 9 abstract factoring equations. Essential background for Year 12 Partial Fractions and A-Level integration.
Autumn	Pure 2: Partial Fractions	Decomposing complex algebraic fractions into linear and repeated fractional components using equating coefficients and substitution.	Decomposition, linear components, repeated roots equations.	Follows directly from algebraic division. Prerequisite for binomial expansions and advanced Year 13 integration tasks.
Autumn	Pure 1: Quadratics & Discriminant	Solving indices equations, working with surds, using the discriminant to identify real/imaginary roots, and solving disguised quadratics.	Discriminant, real vs complex roots, quadratic form, indices properties.	Consolidates GCSE Higher tier algebra. Vital underpinnings for complex number introduction later in the term.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Autumn	Stats 1: Data Presentation & Sampling	Distinguishing qualitative and quantitative fields; selecting random, systematic, stratified, or quota samples; calculating central tendency and measures of spread from frequency tables.	Sampling frame, bias risk, continuous variables, standard deviation, outliers.	Upgrades GCSE statistical analysis. Crucial groundwork for manipulating the Large Data Set (LDS) and correlation modeling.
Autumn	Pure 1: Binomial Expansion	Expanding brackets up to any positive integer power n using combination coefficients or Pascal's Triangle.	Factorial notation, combinations, expansion series, terms coefficient.	Transitions from basic binomial expanding models at GCSE. Direct prerequisite for rational negative index series expansions.
Autumn	Pure 2: Binomial Expansion II	Expanding (1 + x)^n for rational, negative, and fractional values of n; identifying the valid interval constraints of the series expansion.	Rational index, interval of validity, convergence criteria, partial fraction linking.	Advances positive integer binomial expansion. Necessary for processing approximations in structural engineering models.
Autumn	Pure 1: Graphs & Cubic/Quartic Functions	Sketching cubic, quartic, and reciprocal functions; finding intersection points, coordinates, and analyzing graph trends.	Intercepts, roots of polynomial curves, coordinate geometry symmetry.	Extends Key Stage 4 graph sketching. Connects with numerical methods and transformation functions.
Autumn	Pure 1: Straight Line Graphs	Using the line equation forms y - y1 = m(x - x1) and ax + by + c = 0, calculating	Gradient, perpendicularity, intercept lines,	Deepens Key Stage 3 linear tracks. Mandatory foundational skill for coordinate calculus, tangents, and mechanics normals.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
		midpoints, horizontal distances, and perpendicular bisectors.	intersection coordinates.	
Autumn	Pure 1: Trigonometry Ratios & Equations	Using exact trigonometric values; solving trigonometric equations across specified coordinate ranges, and analyzing sine/cosine/tangent graph waves.	Quadrant cycles, periodic symmetry, principal values, trigonometric equations.	Consolidates Higher GCSE right-angled geometry. Directly leads to calculus derivatives of trigonometric waveforms.
Autumn	Pure 1: Circles	Completing the square to find the center (a,b) and radius r of a circle equation; solving geometric problems involving tangents, chords, and normal intersections.	Circle radius, coordinate boundaries, tangent-radius normal property.	Upgrades Year 10 circle coordinate rules. Essential for solving geometry optimization tracks in mechanics.

TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Spring	Core Pure 1: Complex Numbers I	Defining imaginary boundaries where i^2 = -1, carrying out complex arithmetic, equating real and imaginary components, and solving quadratics with complex roots.	Real vs imaginary axes, complex conjugates, polynomial roots equations.	Brings a structural close to quadratic algebraic constraints. Essential baseline setup for Year 13 De Moivre wave tracks.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Spring	Core Pure 1: Matrices	Executing matrix addition, subtraction, and multiplication; finding determinants and inverses of 2x2 and 3x3 matrices; solving simultaneous equations using matrix structures.	Determinant bounds, matrix inverse, identity systems, linear transformations.	Introduces non-scalar multi-dimensional algebraic arrays. Prerequisite for advanced 3D vector plane transformations.
Spring	Pure 1: Differentiation	Deriving lines from first principles; calculating standard derivatives of polynomials; finding equations of tangents and normals; optimizing turning parameters.	Rate of change, gradient functions, stationary points, local maxima/minima.	Introduces calculus limits. Establishes core notation and operational fluency required across all fields of physics mechanics.
Spring	Pure 1: Exponentials & Logarithms	Graphing curves of y=e^x; applying logarithm laws to simplify expressions; solving unknown exponents using natural logarithms.	Asymptotes, inverse mapping, base constants, exponential growth modeling.	Advances index systems. Crucial for population modeling, radioactive decay, and linear regression conversions in statistics.
Spring	Pure 2: Functions & Modelling	Defining domain limits, range constraints, evaluating composite mappings gf(x), and computing inverse functional reflections.	Mapping spaces, domain thresholds, self-inverse criteria.	Upgrades algebraic transformations. Critical mapping tool for advanced engineering calculations and calculus boundaries.
Spring	Pure 2: Numerical	Locating polynomial roots	Root approximation,	Applies functional algebra. Offers an alternative analytical toolkit when

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
	Methods I	using sign changes; approximating solutions using cobweb/staircase iteration algorithms and the Newton-Raphson process.	iterative convergence, tangent shortcuts.	exact algebraic factorization is impossible.
Spring	Pure 1: Vectors (2D)	Adding, subtracting, and finding magnitudes of 2D column and unit matrix grid elements i and j; splitting lines into proportional ratios.	Scalar multipliers, vector tracking, translation paths.	Bridges GCSE column shifts. Prerequisite for 3D coordinate geometry tracks and resolving vector forces in mechanics.

TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Summer	Pure 1: Integration	Reversing differentiation for x^n terms; evaluating indefinite integration constants C using boundaries; calculating areas under curves using definite bounds.	Integrals, constant of integration, definite boundaries, area integrals.	Directly paired with differentiation tracks. Forms a mandatory structural requirement for mechanical volume and workload tracking.
Summer	Pure 2: Vectors (3D)	Extending vector translations to 3D spaces using i, j, k components; calculating lines, directional distances, and points in space.	3D coordinates, unit grid paths, direction ratios, spatial distance bounds.	Upgrades 2D vector systems. Establishes the core physical environment framework needed for Year 13 vector systems and forces.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Summer	Mechanics 1: Variable Acceleration & Kinematics	Modeling displacement, velocity, and acceleration tracks using calculus tools; computing boundary values using constants of integration.	Kinematic curves, rates of change, calculus integration boundaries.	Synthesizes Core differentiation and integration toolkits. Directly replaces constant acceleration assumptions with fluid models.
Summer	Core Pure 1: Roots of Polynomials	Analyzing relationships between the roots and coefficients of quadratic, cubic, and quartic functions; evaluating multi-root transformations.	Alpha, beta, gamma coefficients; sum of roots; product parameters; polynomial structures.	Deepens complex number equations and matrix systems, transitioning students fully into Year 13 Further Pure tier success.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Autumn	Core Pure: Matrices Revision	Reviewing matrix transformations, calculating determinants, evaluating linear inverses for 2x2 and 3x3 structures, and solving simultaneous parameter equations using Cramer's rule.	Determinants, inverse matrix mapping, identity systems, transformations.	Builds directly on Year 12 matrix fundamentals. Establishes core system techniques for handling 3D vector transformations and planes.
Autumn	Core Pure: 3D Vectors	Constructing vector and Cartesian equations of lines and planes, calculating scalar/dot products, determining intersection	Direction cosines, normal vectors, scalar product cross-over, coplanar lines.	Extends Year 12 A-Level coordinate spaces. Crucial structural mapping dependency for tracking physical forces in Further Mechanics fields.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
		points, and evaluating shortest perpendicular distances.		
Autumn	Core Pure: Methods in Calculus	Evaluating improper integrals with infinite bounds or undefined parameters, deriving mean values of functions over intervals, and integrating via partial fractions.	Improper limits, functional mean values, residue decomposition values.	Deepens Year 12 definite integration parameters. Direct prerequisite for evaluating continuous area thresholds in advanced statistics.
Autumn	Core Pure: Polar Coordinates	Converting between Cartesian coordinates and polar coordinates (r, theta), sketching curves including cardioids/limacons, and integrating to find areas enclosed by polar paths.	Pole origin, initial line axis, cardioid profiles, sector area integrals.	Introduces non-Cartesian structural grids. Highly useful for advanced kinematic orbital paths and rotational vector modeling.
Autumn	Further Pure 1: Conics II	Investigating parametric properties of parabolas, ellipses, and hyperbolas; finding equations of tangents, normals, asymptotes, and locus patterns.	Focus-directrix ratio, eccentricity parameters, hyperbola asymptotes, parameters.	Advances from Year 12 parametric functions. Connects geometric paths with multi-variable physics tracks.
Autumn	Core Pure: Hyperbolic Functions	Defining sinh, cosh, and tanh expressions, using inverse hyperbolic	Exponential base representations, catenary curves,	Bridges standard A-Level trigonometric identities with exponential systems. Essential for solving complex fluid mechanics integrals.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
		logarithmic forms, and proving standard hyperbolic identities.	hyperbolic identities mapping.	
Autumn	Further Mechanics 1: Momentum and Impulse	Resolving 2D momentum profiles using i-j vectors, applying vector forms of the impulse-momentum principle, and evaluating kinetic energy conservation criteria.	Vector momentum tracks, directional impulse forces, mass scalar shifts.	Upgrades Higher GCSE momentum models. Directly sets up the logical mechanics required for oblique particle collisions.
Autumn	Further Mechanics 1: Work, Energy and Power	Formulating kinetic and potential energy fields, applying the work-energy principle across variable pathways, and deriving mechanical power metrics.	Conservative fields, potential energy bounds, power multipliers, efficiency index.	Connects Year 12 applied variable forces with functional energy transformations. Foundational for particle constraint tracking.
Autumn	Further Mechanics 1: Hooke's Law	Modeling elastic strings and springs, applying tension formulas based on modulus of elasticity, and calculating elastic potential energy limits.	Elastic modulus, spring stiffness thresholds, extension parameters.	Upgrades linear material assumptions. Crucial for modeling harmonic oscillation bounds and dynamic tension systems.
Autumn	Further Pure 1: Taylor Series	Deriving the Taylor series expansion model for general functions and estimating numerical boundaries around specific	Series approximations, evaluation convergence, polynomial degrees.	Extends Year 12 binomial series models. Essential background for tracking error margins within physical computer algorithms.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
		evaluation limits.		
Autumn	Further Pure 1: t-Formulae	Implementing trigonometric half-angle parameters (t = tan(theta/2)) to completely transform and simplify complex rational trigonometric equations.	Half-angle substitutions, rational polynomial forms, algebraic mapping.	Refines standard Year 13 trigonometric solution limits. Opens up key pathways for solving complex calculus derivatives.
Autumn	Further Pure 1: Inequalities	Solving rational algebraic inequalities across single or multi-variable forms and displaying bounded regions clearly using graphical line overlays.	Critical values, rational constraints, regional boundary lines.	Upgrades Year 10 algebraic inequalities. Essential standard framework for setting up optimization tolerances across structural models.

TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Spring	Core Pure: Differential Equations	Formulating first-order integrating factors to solve linear differentials and modeling second-order homogeneous/non-homogeneous boundary problems.	Integrating factors, complementary functions, particular integrals, transient boundaries.	Synthesizes Core Pure calculus tools. Offers the standard framework required to model real-world physical oscillations and economic circuits.
Spring	Core Pure: Further Complex Numbers	Applying De Moivre's Theorem to integer and	De Moivre exponential tracks,	Deepens Year 12 complex number foundations. Directly prepares students for processing alternating circuit vectors in university-level

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
		fractional exponents, calculating the nth roots of unity, and mapping geometric loci onto Argand grids.	unity roots spacing, complex transformations, loci regions.	physics.
Spring	Further Pure 1: Numerical Methods of Differential Equations	Implementing Taylor series methods and Euler step-size approximations to numerically evaluate complex first-order differential equations.	Step size limits, iteration algorithms, convergence error checking.	Pairs Year 13 Taylor series steps with differential systems. Highly relevant for modeling unpredictable engineering trends.
Spring	Further Pure 1: Further Methods in Calculus	Evaluating high-order partial integration profiles, computing complex algebraic reduction formulae, and tracking curve coordinates.	Reduction formulas, curve tracing, advanced volume matrices.	Brings together advanced algebraic structures and Core calculus. Forms a critical tool for mapping engineering stress distributions.
Spring	Further Mechanics 1: Collisions (Direct & Oblique)	Evaluating 2D elastic oblique impacts of smooth spheres against surfaces or matching sphere configurations, and implementing Newton's coefficient of restitution.	Restitution index, oblique impact angles, kinetic energy losses.	Synthesizes Autumn vector momentum structures. Represents the final advanced baseline module for applied particle dynamics analysis.
Spring	Core Pure: Reducible Differential Equations	Applying algebraic substitution variables to	Substitution transformations,	Finalizes advanced Core Pure differential systems. Prepares students for managing dynamic engineering rate vectors.

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TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
		successfully transform non-linear differential configurations into solvable linear formats.	linear conversions, boundary state fixes.	
Spring	Comprehensive Revision & Paper Strategy	Executing timed past-paper cross-topic reviews across Core Pure 1 & 2, Further Pure 1, and Further Mechanics 1 modules.	Exam pace tracking, error categorization, multi-module links.	Synthesizes all Key Stage 5 Further Mathematics branches. Ensures optimal confidence and paper pacing ahead of university entrance testing.

TERM	TOPIC	CORE LEARNING	KEY CONCEPTS	SEQUENCING
Summer	Comprehensive Revision & Paper Strategy	Executing timed past-paper cross-topic reviews across Core Pure 1 & 2, Further Pure 1, and Further Mechanics 1 modules.	Exam pace tracking, error categorization, multi-module links.	Synthesizes all Key Stage 5 Further Mathematics branches. Ensures optimal confidence and paper pacing ahead of university entrance testing.