	Dallam School Mathematics Curriculum Overview	**Department: AS Level Further Mathematics** **Year Group: 12**

Year 1 – Pure and Decision					
AUTUMN		**SPRING**		**SUMMER**	
Half term 1	**Half term 2**	**Half term 3**	**Half term 4**	**Half term 5**	**Half term 6**
Theme / Topic **Complex Numbers** **Argand Diagrams**	**Theme / Topic** **Matrices**	**Theme / Topic** **Linear Transformations**	**Theme / Topic** **Series** **Proof by Induction**	**Theme / Topic** **Algorithms** **Graphs and Networks** **Algorithms on Graphs**	**Theme / Topic** **Route Inspection** **Linear Programming** **Critical Path Analysis**
By the end of this half term pupils will know *(key knowledge, including tier 3 vocabulary)*					
➢ Imaginary numbers and complex numbers ➢ Multiplication of complex numbers ➢ Complex conjugates ➢ Roots of quadratic equations ➢ Solving cubic and quartic equations ➢ Argand diagrams ➢ Modulus and argument ➢ Modulus-argument form of complex numbers ➢ Loci in the Argand diagram ➢ Regions in the Argand diagram	➢ Matrix multiplication ➢ Determinants ➢ The inverse of a 2x2 matrix ➢ The inverse of a 3x3 matrix ➢ Solving systems of equations using matrices	➢ Linear transformations in two dimensions ➢ Reflections and rotations ➢ Enlargements and stretches ➢ Successive transformations ➢ Linear transformations in three dimensions ➢ The inverse of a linear transformation	➢ Proof by mathematical induction ➢ Proving divisibility ➢ Proving statements involving matrices	➢ Using and understanding algorithms ➢ Flow charts ➢ Bubble sort ➢ Quick sort ➢ Bin-packing ➢ Order of an algorithm ➢ Modelling with graphs ➢ Graph theory ➢ Special types of graphs ➢ Representing graphs and networks using matrices ➢ Kruskal's algorithm ➢ Prim's algorithm ➢ Applying Prim's algorithm to a distance matrix ➢ Using Dijkstra's algorithm to find the shortest path	➢ Eulerian graphs ➢ Using the route inspection algorithm ➢ Linear programming problems ➢ Graphical methods ➢ Locating the optimal point ➢ Solutions with integers values ➢ Modelling a project ➢ Dummy activities ➢ Early and late event times ➢ Critical activities ➢ The float of an activity ➢ Gantt charts

They will understand *(key concepts)*					
➢ Understand the terms 'real part' and 'imaginary part'. ➢ Understand the complex conjugate. ➢ Know that non-real roots of polynomial equations with real coefficients occur in conjugate pairs ➢ Interpret Argand diagrams. ➢ Interpret simple loci in the Argand diagram such as $\lvert z-a\rvert>r$ and $\arg(z-a)=\theta$.	➢ Understand zero and identity matrices. ➢ Calculate determinants of 2×2 and 3×3 matrices ➢ Understand singular and non -singular matrices. ➢ Properties of inverse matrices. ➢ Interpret geometrically the solution and failure of solution of three simultaneous linear equations.	➢ Understand the relationship between matrices and linear transformations ➢ Identify linear transformations from their matrix	➢ Understand and use formulae for the sums of integers, squares and cubes ➢ Contexts include sums of series, divisibility and powers of matrices ➢ Understand proofs using mathematical induction ➢	➢ Understand what an algorithm is ➢ Understand the method behind different types of algorithms ➢ Understand how to perform different types of sorts	➢ Understand what an Eulerian graph is ➢ Understand different graph theory terminology ➢ Understand the reasoning for a linear programming problem ➢ Understand what the optimal point represents
They will know how to *(key skills)*					
➢ be able to solve any quadratic equation with real coefficients; ➢ be able to add, subtract and multiply complex numbers in the form *x* + i*y* 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	➢ be able to find the dimension of a matrix; ➢ be able to add and subtract matrices of the same dimension; ➢ be able to multiply a matrix by a scalar; ➢ be able to multiply conformable matrices. ➢ 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 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; ➢ 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	➢ 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.	➢ be able to trace an algorithm in the form of a flow chart; ➢ be able to trace an algorithm given as instructions written in text; ➢ know how to determine the output of an algorithm and how it links to the input; ➢ be able to determine the order of a given algorithm and standard network problems. ➢ know how to apply a bubble sort algorithm to a list of numbers or words; ➢ know how to apply the quick sort algorithm to a list of numbers or words, clearly identifying the pivots used for each pass; ➢ be able to identify the number of	➢ be able to determine whether a graph is traversable; ➢ be able to apply an algorithm to solve the route inspection problem; ➢ find a route by inspection; ➢ understand the importance of the order of vertices of the graph in finding a route. ➢ know how to formulate a linear programming problem from a real-life problem (write inequalities from worded questions); ➢ be able to form an appropriate objective function to maximise or minimise. ➢ know how to represent a linear programming problem graphically

the Argand diagram such as $\lvert z-a\rvert > r$ and $\arg(z-a)=\theta$. ➢ 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;	➢ 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.	transformation; ➢ be able to find invariant points and lines for a linear transformation.		comparisons and swaps used in a given pass; ➢ be able to identify size, efficiency and order of an algorithm and use them to make predictions; ➢ know how to solve bin packing problems using full bin, first fit, and first fit decreasing algorithms, and understand their strengths and weaknesses. ➢ know the meaning of the vocabulary used in graph theory e.g. degree of a vertex, isomorphic graphs, walks, paths and cycles; ➢ be familiar with different types of graph e.g. complete, planar, isomorphic, simple, connected; ➢ understand graphs represented in matrix form; ➢ be familiar with k notation; ➢ know the definition of a tree; ➢ be able to determine if a graph is Eulerian, semi-Eulerian or neither, and find Eulerian cycles. ➢ understand the meaning of a minimum spanning tree; ➢ be able to apply Kruskal's algorithm to a	and identify the feasible region; ➢ be able to solve linear programming problems to find a maximum or minimum; ➢ be able to interpret solutions in the context of the original real life problem. ➢ be able to model a project by an activity network from a precedence table; ➢ be able to complete a precedence table from a given network; ➢ understand the use of dummies. ➢ know how to carry out a forward pass and backward pass using early and late event times; ➢ be able to interpret and use dummies; ➢ be able to identify critical activities and critical paths. ➢ know how to determine the total float of activities; ➢ be able to construct and interpret Gantt (cascade) charts.

				network to find the minimum spanning tree; ➢ be able to apply Prims algorithm to a network to find the minimum spanning tree; ➢ be able to apply Prim's algorithm to a distance matrix to find the minimum spanning tree. ➢ be able to apply Dijkstra's algorithm to find the shortest path between two vertices in a network; ➢ be able to trace back through a network to be able to find the route corresponding to the shortest path; ➢ be able to consider modifications to an original shortest path problem, for example by dealing with multiple start points or a different end point.	

	Dallam School Mathematics Curriculum Overview	**Department: AS Level Further Mathematics** **Year Group: 13**

Year 2 – Pure and Statistics					
AUTUMN		**SPRING**		**SUMMER**	
Half term 1	**Half term 2**	**Half term 3**	**Half term 4**	**Half term 5**	**Half term 6**
Theme / Topic **Roots of Polynomials** **Vectors**	**Theme / Topic** **Vectors** **Volumes of Revolution**	**Theme / Topic** **Discrete Random Variables** **Poisson Distribution**	**Theme / Topic** **Poisson Distribution** **Hypothesis Testing**	**Theme / Topic** **Chi-squared Testing**	**Theme / Topic** **END OF COURSE**
By the end of this half term pupils will know *(key knowledge, including tier 3 vocabulary)*					
➢ Roots of a quadratic equation ➢ Roots of a cubic equation ➢ Roots of a quartic equation ➢ Expressions relating to the roots of a polynomial ➢ Linear transformations of roots ➢ Equation of a line in three dimensions ➢ Equation of a plane in three dimensions	➢ Scalar product ➢ Calculating angles between lines and planes ➢ Points of intersection ➢ Finding perpendiculars ➢ Volumes of revolution around the x-axis ➢ Volumes of revolution around the y-axis ➢ Adding and subtracting volumes ➢ Modelling with volumes of revolution	➢ Expected value of a discrete random variable ➢ Variance of a discrete random variable ➢ Expected value and variance of a function of X ➢ Solving problems involving random variables ➢ The Poisson distribution ➢ Modelling with the Poisson distribution ➢ Adding Poisson distributions	➢ Mean and variance of a Poisson distribution ➢ Mean and variance of the binomial distribution ➢ Using the Poisson distribution to approximate the binomial distribution ➢ Testing for the mean of a Poisson distribution ➢ Finding critical regions for a Poisson distribution	➢ Goodness of fit ➢ Degrees of freedom and the chi-squared family of distributions ➢ Testing a hypothesis ➢ Testing the goodness of fit with discrete data ➢ Using contingency tables	**END OF COURSE**

They will understand *(key concepts)*					
➢ Understand and use the complex conjugate of a complex number ➢ Know that non-real roots of polynomial equations with real coefficients occur ➢ Understand 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). ➢ Understand the relationship between roots and coefficients of polynomial equations up to the quartic equations ➢ Form a polynomial equation whose roots are a linear transformation of the roots of a given polynomial equation (of at least cubic degree) ➢ Understand the vector and Cartesian forms of an equation of a straight line in 3D ➢ Understand the vector and Cartesian forms of the equation of a plane	➢ Calculate the scalar product and use it to express the equation of a plane, and to calculate the angle between two lines, the angle between two planes and the angle between a line and a plane ➢ Check whether vectors are perpendicular by using the scalar product ➢ Understand the Cartesian forms of an equation of a straight line in three dimensions ➢ Understand the vector and Cartesian forms of the equation of a plane ➢ Understand how we derive formula for volumes of revolution ➢ Understand how to integrate to find a volume	➢ Calculation of the mean and variance of discrete probability distributions ➢ Extension of expected value function to include E(g(X)) ➢ Be able to use the Poisson distribution to model a real-world situation ➢ Know the conditions for a Poisson distribution ➢ Know the additive property of Poisson distributions	➢ The mean and variance of the binomial distribution and the Poisson distribution ➢ The use of the Poisson distribution as an approximation to the binomial distribution ➢ Understand and be able to apply the language of statistical hypothesis testing ➢ Be able to carry out hypothesis tests to test for the mean of a Poisson distribution	➢ Goodness of fit tests ➢ Contingency Tables ➢ The null and alternative hypothesis ➢ The use of $\sum n$ =(Oi−Ei) 2 / Ei as an approximate x2 statistic ➢ Degrees of freedom	**END OF COURSE**

They will know how to *(key skills)*					
➢ 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. ➢ 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). ➢ 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; ➢ be able to calculate the perpendicular distance from a point to a line or to a plane. ➢ be able to derive formulae for and calculate volumes of revolution about both	➢ be able to calculate the mean and variance of discrete probability distributions using $\mathrm{E}(X) = \mu = \sum x\mathrm{P}(X = x)$ and $\mathrm{Var}(X) = \sigma^2 = \sum x^2\mathrm{P}(X = x) - \mu^2$; ➢ know how to find the expectation of a function of a random variable. ➢ be able to use the Poisson distribution to model a real-world situation; ➢ know the conditions for a Poisson distribution; ➢ be able to comment critically on the appropriateness of using the Poisson distribution as a model; ➢ know how to use calculators to calculate probabilities including cumulative probabilities; ➢ know the additive property of Poisson distributions.	➢ know how to find the mean and variance of the binomial distribution; ➢ know how to find the mean and variance of the Poisson distribution; ➢ be able to solve problems involving the mean and variance of the binomial and Poisson distributions. ➢ be able to use the Poisson distribution as an approximation to the binomial distribution; ➢ know when it is appropriate to use the Poisson distribution as an approximation to the binomial distribution. ➢ understand and be able to apply the language of statistical hypothesis testing; ➢ be able to carry out hypothesis tests to test for the mean of a Poisson distribution.	➢ know and be able to use the process of a goodness of fit test; ➢ know how to find the number of degrees of freedom of the expected values, including when one or more parameters are estimated from the data; ➢ be able to use $\sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$ as an approximate χ^2 statistic; ➢ be able to apply goodness of fit tests to include the discrete uniform, binomial and Poisson distributions; ➢ be able to show frequencies by means of a contingency table; ➢ know how to obtain p-values from calculators; ➢ be able to use tables to find critical values.	**END OF COURSE**

	the *x* and *y*-axes.				