A Level Further Maths Year 1 Scheme of Work

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| **Unit** | **Week** | **Content** | **Resources** |
| Complex numbers | Week 1 | Add, subtract, multiply and divide complex numbers in the form with and real  Understand and use the terms ‘real part’ and ‘imaginary part’ | **Further Maths 1 - Complex Numbers** |
| Week 2 | Understand and use the complex conjugate |
| Use and interpret Argand diagrams |
| Convert between the Cartesian form and the modulus-argument form of a complex number |
| Week 3 | Multiply and divide complex numbers in modulus-argument form |
| Construct and interpret simple loci in the Argand diagram such as and | **Further Maths 2 - Argand diagrams** |
| Know that non-real roots of polynomial equations with real coefficients occur in conjugate pairs.  Solve any quadratic equation with real coefficients  Solve cubic or quartic equations with real coefficients given sufficient information to deduce at least one root for cubics or at least one complex root or quadratic factor for quartics. | **Further Maths 3 - Complex Roots of Polynomials** |
| Matrices | Week 4 | Add, subtract and multiply conformable matrices  Multiply a matrix by a scalar. | **Further Maths 4 - Matrices** |
| Understand and use zero and identity matrices. |
| Use matrices to represent linear transformations in 2-D  Successive transformations  Single transformations in 3-D (3-D transformations confined to reflection in one of , , or rotation about one of the coordinate axes). | **Further Maths 5 - Matrices Transformation** |
| Week 5 | Find invariant points and lines for a linear transformation | **Further Maths 6 - Invariant point and lines** |
| Calculate determinants of 2×2 matrices | **Further Maths 7 - Determinants and Inverses** |
| Understand and use singular and non-singular matrices; properties of inverse matrices  Calculate and use the inverse of non-singular 2×2 matrices. |
| Further algebra and functions | Week 6 | Understand and use the relationship between roots and coefficients of polynomial equations up to quartic equations | **Further Maths 8 - Roots of polynomials** |
| Form a polynomial equation whose roots are a linear transformation of the roots of a given polynomial equation of at least cubic degree. |
| Understand and use formulae for the sums of integers, squares and cubes and use these to sum other series. | **Further Maths 9 - Summations** |
| Further algebra and functions | Week 7 | Understand and use the method of differences for summation of series | **Further Maths 9 - Summations** |
| Inequalities involving polynomial equations (cubic and quartic). | **Further Maths 10 - Cubic and quartic inequalities** |
| Week 8 | Solving inequalities such as  algebraically. | **Further Maths 11 - Graphing rational functions** |
| Graphs of rational functions of form  Asymptotes, points of intersection with coordinate axes or other straight lines  Associated inequalities. | **Further Maths 12 - Solving rational inequalities** |
| Graphs of rational functions of form , including cases when some of these coefficients are zero  Asymptotes parallel to coordinate axes. | **Further Maths 13 - Stationary point of rational functions** |
| Graphs | Week 9 | Understand and use the language of graphs including: ‘vertex’, ‘edge’, ‘trail’, ‘cycle’, ‘connected’, ‘degree’, ‘subgraph’, ‘subdivision’, ‘multiple edge’ and ‘loop’ | **Further Maths 14 - Discrete graphs** |
| Understand and use simple graphs, simple-connected graphs and trees. | **Further Maths 15 - Complete and bipartite graphs** |
| Understand and use complete graphs and bipartite graphs, including adjacency matrices and the complement of a graph | **Further Maths 16 - Adjacency matrices** |
| Graphs | Week 9 | Understand and use Euler’s formula for connected planar graphs | **Further Maths 17 - Planar graphs** |
| Identify or prove properties of a graph including that a graph is Eulerian, semi-Eulerian or Hamiltonian | **Further Maths 18 - Eulerian and semi Eulerian graphs** |
| Networks | Week 10 | Understand and use the language of networks including: ‘node’, ‘arc’ and ‘weight’. | **Further Maths 19 - Networks** |
| Solve Route Inspection problems | **Further Maths 20 - Route inspection problems** |
| Solve network optimisation problems using spanning trees | **Further Maths 21 - Spanning Trees** |
| Find and interpret upper bounds and lower bounds for the Travelling Salesperson problem | **Further Maths 22 - Travelling Salesperson problems** |
| Evaluate, modify and refine models which use networks |
| Interpret flow problems represented by a network of directed arcs. | **Further Maths 23 - Network Flows** |
| Find the value of a cut and understand its meaning |
| Use and interpret the maximum flow-minimum cut theorem |
| Introduce supersources and supersinks to a network |
| Critical path analysis | Week 11 | Construct, represent and interpret a precedence (activity) network using activity-on-node | **Further Maths 24 - Critical Path Analysis** |
| Determine earliest and latest start and finish times for an activity network |
| Identify critical activities, critical paths and the float of non-critical activities |
| Refine models and understand the implications of possible changes in the context of critical path analysis |
| Linear programming | Week 12 | Formulate constrained optimisation problems | **Further Maths 25 - Linear programming** |
| Solve constrained optimisation problems via graphical methods |
| Game theory for zero-sum games | Week 13 | Understand, interpret and construct pay-off matrices | **Further Maths 26 - Game Theory play-safe dominance** |
| Find play-safe strategies and the value of the game |
| Week 14 | Prove the existence or non-existence of a stable solution |
| Identify and make use of dominated strategies |
| Find optimal mixed strategies for a game including use of graphical methods | **Further Maths 27 - Game Theory mixed strategy** |
| Mock Exam | Week 15 | Mock Exam |  |
| Binary operations and group theory | Week 16 | Understand and use binary operations including use of modular arithmetic and matrix multiplication | **Further Maths 28 - Binary operations** |
| Understand, use and prove the commutativity of a binary operation |
| Week 17 | Understand, use and prove the associativity of a binary operation  Understand and prove the existence of an identity element for a given set under a given binary operation |
| Construct a Cayley Table for a given set and binary operation. | **Further Maths 29 - Binary operations Cayley table** |
| Further vectors | Week 18 | Understand and use the vector and Cartesian forms of an equation of a straight line in 3-D | **Further Maths 30 - Vector equations of lines** |
| Calculate the scalar product and use it to calculate the angle between two lines. | **Further Maths 31 - Scalar product** |
| Check whether vectors are perpendicular by using the scalar product |
| Find the intersection of two lines.  Calculate the perpendicular distance between two lines, from a point to a line. |
| Further calculus | Week 19 | Derive formulae for and calculate volumes of revolution | **Further Maths 32 - Volume of revolution** |
| Understand and evaluate the mean value of a function | **Further Maths 33 - Mean value of a function** |
| Polar coordinates | Week 20 | Understand and use polar coordinates and be able to convert between polar and Cartesian coordinates | **Further Maths 34 - Polar coordinates** |
| Sketch curves with given as a function of , including use of trigonometric functions |
| Conic sections | Week 21 | Sketching graphs of curves with equations CONIC EQUATIONS including intercepts with axes and equations of asymptotes of hyperbolas. | **Further Maths 35 - Conic section** |
| Single transformations of curves involving translations, stretches parallel to coordinate axes and reflections in the coordinate axes and the lines y = ± x. | **Further Maths 36 - Conic section transformations** |
| Hyperbolic functions | Week 22 | Understand the definitions of hyperbolic functions , and and be able to sketch their graphs | **Further Maths 37 - Hyperbolic functions** |
| Understand and be able to use the definitions of the inverse hyperbolic functions |
| Hyperbolic functions | Week 23 | Derive and use the logarithmic forms of the inverse hyperbolic functions | **Further Maths 37 - Hyperbolic functions** |
| Week 24 | Understand and use  Understand and use |
| Maclaurin series | Week 25 | Recognise and use the Maclaurin series for , , , , and , and be aware of the range of values of x for which they are valid (proof not required). | **Further Maths 38 - Maclaurin series** |
| Proof | Construct proofs using mathematical induction; contexts include sums of series, divisibility, and powers of matrices | **Further Maths 39 - Proof by induction** |
| Discrete random variables and expectation | Week 26 | Understand DRVs with distributions given in the form of a table or function | **Further Maths 40 - Discrete random variables** |
| Evaluate probabilities for a DRV |
| Evaluate measures of average and spread for a DRV to include mean, variance, standard deviation, mode or median |
| Understand expectation and know the formulae: |
| Week 27 | Understand expectation of linear functions of DRVs and know the formulae: | **Further Maths 40 - Discrete random variables** |
| Know the discrete uniform distribution defined on the set {1, 2, …, n}. Understand when this distribution can be used as a model. |
| Proof of mean and variance of discrete uniform distribution. |
| Poisson distribution | Week 28 | Understand conditions for a Poisson distribution to model a situation. Understand terminology | **Further Maths 41 - Poisson distribution** |
| Know Poisson formula and calculate Poisson probabilities using the formula or equivalent calculator function |
| Know mean, variance and standard deviation of a Poisson distribution.  Use the result that, if then the mean and variance of are equal |
| Week 29 | Understand the distribution of the sum of independent Poisson distributions. |
| Formulate hypotheses and carry out a hypothesis test of a population mean from a single observation from a Poisson distribution using direct evaluation of Poisson probabilities. | **Further Maths 42 - Poisson distribution hypothesis testing** |
| Type I and Type II errors | Understand Type I and Type II errors and define in context. Calculate the probability of making a Type I error from tests based on a Poisson or Binomial distributions |
| Continuous random variables | Week 30 | Understand and use a probability density function, , for a continuous distribution and understand the differences between discrete and continuous distributions | **Further Maths 43 - Continuous random variables** |
| Find the probability of an observation lying in a specified interval |
| Find median and quartiles for given probability density function, |
| Exams | Week 31 | Exam Week |  |
| Continuous random variables | Week 32 | Find mean, variance and standard deviation for given CRV function, .  Know the formulae: | **Further Maths 43 - Continuous random variables** |
| Understand expectation of linear functions of CRVs and know the formulae:    Know the formula  Find the mean, variance and standard deviation of functions of a continuous random variable such as , , |
| Know that if and are independent (discrete or continuous) random variables then and |
| Chi tests for association | Week 33 | Construction of contingency tables | **Further Maths 44 - Chi-squared tests** |
| Use of as an approximate statistic with appropriate degrees of freedom |
| Know and use the convention that all should be greater than 5 |
| Identification of sources of association in the context of a question |
| Confidence intervals | Week 34 | Construct symmetric confidence intervals for the mean of a normal distribution with known variance. | **Further Maths 45 – Confidence intervals** |
| Construct symmetric confidence intervals from large samples, of the mean of a normal distribution with unknown variance. |
| Make inferences from constructed or given confidence intervals |