

# University of York

## Computer Science and Engineering Undergraduate Admissions

### Core Mathematics advised for entry

This chart shows the level of Mathematics that is assumed on entry to our programmes, and therefore that we advise applicants to acquire before entry. It is derived partly from the QCA document *Subject criteria for Mathematics*, and partly from a version of that document prepared by the Department of Mathematics at York.

The *Background knowledge* section describes the material that you would normally be familiar with before embarking on an A-level programme or equivalent qualification.

The *Proof* section describes the general techniques, ideas and ways of thinking that you would bring to bear on the other topics of the *A-level core content* sections.

The *A-level core content* sections describe the topics that all A-level programmes would have in common, whatever the mix of modules that you chose to take. The chart does *not* show the additional content of such modules beyond that common core, *nor* does it include the further topics that you would cover if you chose to take a double A-level in mathematics.

The chart is displayed as tables with empty boxes to make it easy for you use as a checklist if you print it.

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## Background knowledge

	Topics	Tick
(a)	The arithmetic of integers, including GCDs (HCFs) and LCMs. The arithmetic of rational numbers (i.e. fractions), and of real numbers.	
(b)	The law of indices for positive integer exponents.	
(c)	The solution of problems involving ratio and proportion. Similar triangles, and links between length, area and volume of similar figures.	
(d)	Elementary algebra: including multiplying out brackets, factorising quadratics with integer coefficients and solution of simultaneous linear equations by eliminating a variable.	
(e)	Changing the subject of a simple formula or equation.	
(f)	The equation $y = mx + c$ for a straight line. Gradient and intercept.	
(g)	The distance between two points, in 2 dimensions, with given co-ordinates.	
(h)	Solution of triangles using trigonometry: the sine and cosine rules, and the area of a triangle in the form $\frac{1}{2}ab\sin C$ .	
(i)	Volume of cone and sphere.	
(j)	The following properties of a circle: the angle in a semicircle is a right angle, the perpendicular from the centre to a chord bisects the chord, a radius is perpendicular to its tangent at the circumference.	

## A-level core: Proof

These ideas of proof should pervade all of the subsequent material.

	Topics	Tick
(a)	Construction and presentation of mathematical arguments through appropriate use of logical deduction and precise statements involving correct use of symbols and appropriate connecting language.	
(b)	Correct understanding and use of mathematical language and grammar in respect of terms such as 'equals', 'indidentally equals', 'therefore', 'because', 'implies', 'is implied by', 'necessary', 'sufficient', and notation such as $\therefore$ , $\Rightarrow$ , $\Leftarrow$ and $\Leftrightarrow$ .	
(c)	Methods of proof, including proof by contradiction and disproof by counter-example.	

## A-level core content: (1) Algebra and Functions

	Topics	Tick
(a)	Laws of indices for all rational exponents.	
(b)	Use and manipulation of surds.	
(c)	Quadratic functions and their graphs. The discriminant of a quadratic function. Completing the square. Solution of quadratic equations.	
(d)	Simultaneous equations: analytical solution by substitution, e.g. of one linear and one quadratic equation.	
(e)	Solution of linear and quadratic inequalities.	
(f)	Algebraic manipulation of polynomials, including expanding brackets and collecting like terms. Factorisation. Use of the Factor Theorem and the Remainder Theorem. Simplification of rational expressions including factorisation and cancelling. Algebraic division.	
(g)	Graphs of functions. Sketching curves defined by simple equations. Geometrical interpretation of algebraic solution of equations. Use of intersection points of graphs of functions to solve equations.	
(h)	Definition of a function. Domain and range of functions. Composition of functions. Inverse functions and their graphs.	
(i)	The modulus (i.e. absolute value) function.	
(j)	Knowledge of the effect of simple transformations on the graph of $y = F(x)$ as represented by $y = aF(x)$ , $y = F(x) + a$ , $y = F(x + a)$ , $y = F(ax)$ . Combinations of these transformations.	
(k)	Rational functions. Partial fractions (with denominators not more complicated than repeated linear terms).	
(l)	The Remainder Theorem.	

## A-level core content: (2) Plane Co-ordinate Geometry

	Topics	Tick
(a)	Equation of a straight line, including the forms $y - y_0 = m(x - x_0)$ and $ax + by + c = 0$ . Conditions for two straight lines to be parallel or perpendicular to each other.	
(b)	Co-ordinate geometry of the circle using the equation of a circle in the form $(x - a)^2 + (y - b)^2 = r^2$ .	
(c)	Parametric equations of curves and conversion between Cartesian and parametric forms.	

### A-level core content: (3) Sequences and Series

	Topics	Tick
(a)	Sequences, including those given by a formula for the $n$ th term and those generated by a simple relation of the form $x_{n+1} = f(x_n)$ .	
(b)	Arithmetic series, including the formula for the sum of the first $n$ natural numbers.	
(c)	The sum of a finite geometric series. The sum to infinity of a convergent geometric series, including the use of $ r  < 1$ .	
(d)	The binomial expansion of $(1 + x)^n$ for positive integer $n$ . The notations $n!$ and $\binom{n}{r}$ .	
(e)	The binomial series for any rational $n$ .	

### A-level core content: (4) Trigonometry

	Topics	Tick
(a)	Radian measure, including the use for length of arc and area of sector.	
(b)	Sine, cosine and tangent functions. Their graphs, symmetries and periodicity.	
(c)	Knowledge of secant, cosecant and cotangent, and of arcsin, arccos and arctan. Their relationships to sine, cosine and tangent. Understanding their graphs and appropriate restricted domains.	
(d)	Knowledge and use of $\tan\theta = \frac{\sin\theta}{\cos\theta}$ and $\sin^2\theta + \cos^2\theta = 1$ . Knowledge and use of $\sec^2\theta = 1 + \tan^2\theta$ and $\operatorname{cosec}^2\theta = 1 + \cot^2\theta$ .	
(e)	Knowledge and use of the double angle formulae, of formulae for $\sin(A \pm B)$ , $\cos(A \pm B)$ and $\tan(A \pm B)$ , and of expressions for $a\cos\theta + b\sin\theta$ in the equivalent forms of $r\cos(\theta \pm \alpha)$ or $r\sin(\theta \pm \alpha)$	
(f)	Solution of simple trigonometric equations in a given interval.	

## A-level core content: (5) Exponentials and Logarithms

	Topics	Tick
(a)	The function $y = a^x$ and its graph. In particular, the function $y = e^x$ and its graph.	
(b)	Exponential growth and decay. The function $\ln x$ and its graph, and as the inverse function of $e^x$ .	
(c)	The laws of logarithms: $\log_a b \cdot \log_b c = \log_a c$ $\log_a x + \log_a y = \log_a (xy)$ $\log_a x - \log_a y = \log_a \left(\frac{x}{y}\right)$ $k \log_a x = \log_a (x^k)$ .	
(d)	The solution of equations of the form $a^x = b$ .	

## A-level core content: (6) Differentiation

	Topics	Tick
(a)	The derivative of $f(x)$ as the gradient of the tangent to the graph $y = f(x)$ at a point on the graph. The gradient of the tangent as a limit. Interpretation of the derivative as a rate of change. Second-order derivatives.	
(b)	Differentiation of $x^n$ w.r.t. $x$ , and related sums and differences. Differentiation of $e^x$ , $\ln x$ , $\sin x$ , $\cos x$ and $\tan x$ , and their sums and differences.	
(c)	Applications of differentiation to gradients, tangents and normals, maxima and minima and stationary points, increasing and decreasing functions.	
(d)	Differentiation using the product rule, the quotient rule, the chain rule, and $\frac{dy}{dx} = \frac{1}{\left[\frac{dx}{dy}\right]}$ .	
(e)	Differentiation of simple functions defined implicitly or parametrically.	
(f)	Formation of simple differential equations.	

### A-level core content: (7) Integration

	Topics	Tick
(a)	Indefinite integration as the reverse of differentiation.	
(b)	Integration of $x^n dx$ . Integration of $e^x$ , $\frac{1}{x}$ , $\sin x$ , $\cos x$ .	
(c)	Evaluation of definite integrals. Interpretation of the definite integral as the area under a curve.	
(d)	Evaluation of volume of revolution.	
(e)	Simple cases of integration by substitution and integration by parts. These methods as the reverse processes of the chain rule and the product rule respectively.	
(f)	Simple cases of integration using partial fractions.	
(g)	Analytical solution of simple first-order differential equations with separable variables.	

### A-level core content: (8) Numerical Methods

	Topics	Tick
(a)	Location of roots of $f(x) = 0$ by considering changes of sign of $f(x)$ in an interval of $x$ in which $f(x)$ is continuous.	
(b)	Approximate solution of equations using simple iterative methods, including recurrence relations of the form $x_{n+1} = f(x_n)$ .	
(c)	Numerical integration of functions, especially by using the trapezium rule.	

### A-level core content: (9) Vectors

	Topics	Tick
(a)	Vectors in two and three dimensions.	
(b)	Magnitude of a vector.	
(c)	Algebraic operations of vector addition and of multiplication by scalars, and their geometrical interpretations.	
(d)	Position vectors. The distance between two points. Vector equations of lines.	
(e)	The scalar product. Its use for calculating the angle between two lines.	