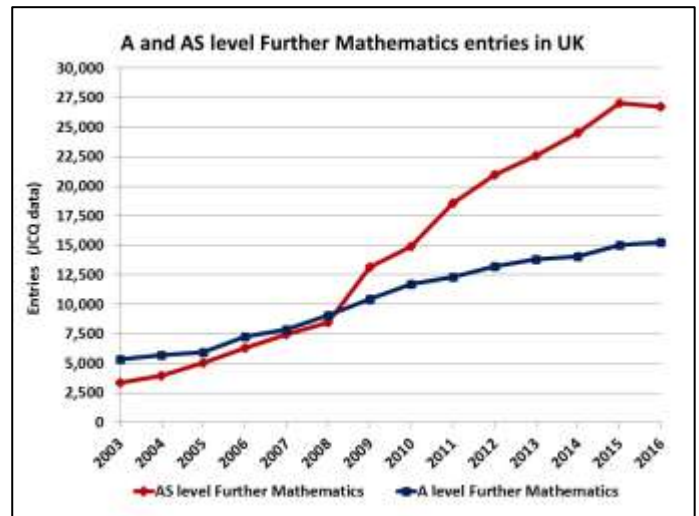


## A level Further Mathematics

**The number of students taking A level Further Mathematics in the UK continues to increase.**

**In 2016 over 15 000 students entered A level Further Mathematics, more than double the number in 2005. The number taking AS Further Mathematics has risen even more sharply, by 429%.**

**There are now more students taking Further Mathematics than ever before.**



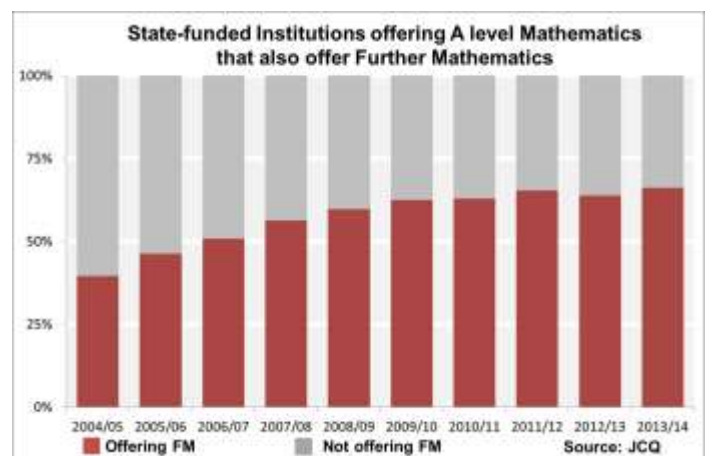
The table shows the entries in the UK for A/AS level Mathematics and Further Mathematics for 2016.

Qualification	Entries in 2016	Entries in 2010	Entries in 2005	% increase since 2010	% increase since 2005
A level Mathematics	92 163	77 001	52 897	20%	75%
A level Further Mathematics	15 257	11 682	5 933	31%	157%
AS level Mathematics	162 741	112 847	68 178	44%	139%
AS level Further Mathematics	26 742	14 884	5 054	80%	429%

(data source: JCQ)

### A number of factors have contributed to the rise in entries for A/AS Further Mathematics

- **Over two thirds of state funded schools/ colleges now offer Further Mathematics courses.** In 2004/5 less than 40% of the state-funded A level Mathematics providers in England had students taking A level Further Mathematics. In 2014/15 this proportion had grown to 68%.
- **Promotion of mathematics A levels through careers presentations and enrichment events aimed at GCSE students.** In 2015/16 the Further Mathematics Support Programme organised events for over 12 000 14-16 year olds.



- **Increased numbers of A\* and A grade students at GCSE Mathematics.** Prior attainment at GCSE is a key factor in students' choices of A level subjects. The proportion of A\*/A grades in 2016 was 15.9% compared with 13.0% in 2005.
- **Increasing awareness of students and their teachers that Further Mathematics is an essential or desirable subject for progression to Mathematics, Engineering, Physics and other STEM degree courses.** Information provided on university websites and at HE open days encouraging the study of A/AS Further Mathematics helps to convince students, teachers and school leaders of the need for it.

## The current content of AS and A2 Further Mathematics

### AS Further Mathematics

- This consists of 3 modules.
- Further Pure 1 is compulsory.
- Students take 2 other modules, which are typically 2 additional application modules (either Mechanics 1, Mechanics 2, Statistics 1, Statistics 2, Decision 1, or Decision 2).
- Alternatively they could take Further Pure 2 or Further Pure 3 as one or both of these options.

*Typical Content of Further Pure 1 (FP1) modules*

#### Introduction to Complex Numbers

Definitions, basic arithmetic  
Argand diagrams  
Polynomial equations with complex roots

#### Sum of Power Series

Numerical methods for solving equations  
Graphs of Rational Functions

#### Introduction to Matrices

Definitions, basic arithmetic  
Matrices as transformations  
Determinant and inverse of 2x2

#### Proof by Induction

Coordinate Systems  
Roots of Polynomials

### A2 Further Mathematics

- This consists of an additional 3 modules (on top of the 3 for AS Further Mathematics).
- Students take one additional Further Pure module, which is compulsory, either FP2 or FP3.
- Students then choose 2 other modules, which are typically 2 more application modules.
- Alternatively they may take other Further Pure modules instead of an application.

Content of Further Pure 2 and Further Pure 3 varies across the different specifications. Depending on which board students follow and which module(s) they take they will meet some of the following topics.

*Typical Content of Further Pure 2 and 3 modules*

#### Further Complex Numbers

Polar form  
De Moivre's theorem  
Transformations  
Exponential notation  
nth roots of complex numbers  
Proving hyperbolic trigonometric identities

#### Coordinate Systems

Polar coordinates  
Intrinsic coordinates  
Conic sections  
Maclaurin & Taylor series and approximations

#### Hyperbolic Functions

Definitions, properties and identities  
Use in calculus

#### Groups

Definition and properties  
Lagrange's theorem

#### Further Matrices

Determinant, inverse of 3x3 matrices  
Use in solving linear simultaneous equations,  
Equations of planes and geometric interpretation  
Characteristic polynomial  
Eigenvalues and eigenvectors

#### Calculus

Using inverse trigonometric functions,  
Hyperbolic trigonometric functions  
More advanced substitution

#### Differential Equations

1st and 2nd order linear ODEs  
Using an integrating factor

#### Vectors

Vector product, triple scalar product

#### Numerical Methods

Iterative methods  
Newton-Raphson method

Further details can be found in the document *Understanding the UK Mathematics Curriculum Pre-Higher Education* [www.mei.org.uk/files/pdf/pre-university-maths-guide-2016.pdf](http://www.mei.org.uk/files/pdf/pre-university-maths-guide-2016.pdf)

## A level Mathematics and Further Mathematics specifications are changing

The new draft specifications have been submitted to Ofqual for accreditation. First teaching begins September 2017 and the first awards of the new AS and A level Mathematics will be in August 2018, together with AS Further Mathematics. First award of A level Further Mathematics will be August 2019.

### The main changes to the AS/A level Mathematics and Further Mathematics specifications

- All AS and A levels will be linear with examinations in the summer.
- AS levels can be co-taught with A level, but will have separate examinations. Marks in AS will not count towards the A level grade.
- Since the first teaching of the courses will be from 2017, all students will have also done the new GCSE Mathematics course and will be better prepared for A level.
- For AS and A level Mathematics 100% of the content is prescribed. All students will have covered the same topics whatever examination board they have followed.
- AS and A level Mathematics will consist of a pure mathematics section (about two thirds of the content, i.e. similar in size and content to the current core), a statistics section and a mechanics section (each about one sixth of the content).
- Decision mathematics has been removed from AS and A level Mathematics, but it is permitted as an option in Further Mathematics.
- For A level Further Mathematics 50% of the content is prescribed and common to all specifications. This is a core of pure mathematics techniques. Students will have some choice over additional applied and pure mathematics content that is studied depending on the examination board followed.

All Mathematics specifications must encourage students to:

- reason logically and recognise incorrect reasoning
- generalise mathematically
- construct mathematical proofs
- solve problems in context
- understand the relationship between problems in context and mathematical models
- read and comprehend mathematical arguments
- read and comprehend mathematical articles
- use technology such as calculators and computers effectively

The FMSP website page [www.furthermaths.org.uk/2017](http://www.furthermaths.org.uk/2017) has further details of all four main specifications in England together with summaries and comparisons of the content and structure of the different specifications for Mathematics and Further Mathematics.

## About the Further Mathematics Support Programme



The Further Mathematics Support Programme (FMSP) is funded by the Department for Education and managed by Mathematics in Education and Industry (MEI), an independent educational charity.

FMSP Area Coordinators, covering the whole of England, work with schools and colleges to support and promote the study of AS and A level Mathematics and Further Mathematics and to arrange Further Mathematics tuition for students when their schools and colleges cannot provide it themselves.

**Our aim is to ensure that every student who could benefit from studying Further Mathematics has access to appropriate tuition.**

All English schools and colleges can register free of charge with the FMSP to receive expert advice about support. Registered schools receive free access to extensive online resources and get regular updates about professional development opportunities for teachers and enhancement and enrichment events for KS3, KS4 and sixth-form students provided by the FMSP.

To help schools and colleges to offer Further Mathematics, the FMSP:

- engages with around 4000 schools and colleges providing news, information, and resources;
- delivers over 3000 teacher days of professional development each year through a range of innovative and flexible courses for GCSE and A level Mathematics and Further Mathematics, including support for higher-level problem-solving skills and preparation for STEP, AEA and the MAT examinations;
- promotes the study of A level Mathematics and Further Mathematics through enrichment events, talks and careers presentations to over 12 000 14-16 year-old students each year;
- provides face-to face and online tuition so that schools/colleges can offer Further Mathematics. The FMSP has provided tuition to thousands of students tutoring around 400 students each year;
- maintains local networks of teachers to share and develop good practice.



## FMSP support for Higher Education Institutions and students preparing to go to university

- The FMSP promotes the benefits of studying of AS/A level Mathematics and Further Mathematics by providing information to teachers, students and parents. The key message being that studying mathematics makes the transition to a many university courses easier. These qualifications offer transferable skills for all STEM subjects, the social sciences, business and economics and enable students to distinguish themselves as able mathematicians at university and in the employment market.
- The FMSP supports students preparing for STEP, AEA and the MAT examinations, through online tuition and resources and has established regular problem-solving support classes for year 12 and year 13 students in over 30 locations. Many of these classes take place in partnership with local universities and colleges. [furthermaths.org.uk/supporting-step](http://furthermaths.org.uk/supporting-step)
- The FMSP also provides CPD for teachers to enable them to support STEP/AEA/MAT in their institution and to enhance students' mathematical skills through exposing them to unfamiliar questions.
- The FMSP liaises with universities to encourage clear signalling of the importance of studying AS/A level Mathematics and Further Mathematics in their entry requirements.
- The FMSP works with universities to develop pre-university mathematics resources to help prepare students for a range of degree courses. [www.furthermaths.org.uk/universities](http://www.furthermaths.org.uk/universities)

For more information contact [admin@furthermaths.org.uk](mailto:admin@furthermaths.org.uk)