COURSE DETAILS

**Course Code:** F17CC  
**Full Course Title:** Introduction to University Mathematics  
**SCQF Level:** 7  
**SCAF Credits:** 15  
**Available as Elective:** No

DELIVERY LEVEL

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<th>Postgraduate Taught:</th>
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<th>Postgraduate Research:</th>
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Additional Information:

COURSE AIMS

The course aims to provide a bridge between school and university (mainly, non-calculus) mathematics.

It will provide an introduction to the culture of mathematics including discussions of history, modern applications and the nature of reasoning, problem-solving and proofs.

In addition, basic skills will be developed in elementary combinatorics, complex numbers and polynomials, the algebra of matrices and their applications and geometry and vectors.

LEARNING OUTCOMES – SUBJECT MASTERY

By the end of the course, students should be able to:

- carry out all the procedures described in the syllabus;
- be able to read and construct simple proofs;
- understand how and why mathematics at university is different from mathematics at school

LEARNING OUTCOMES – PERSONAL ABILITIES

- Demonstrate the ability to learn independently
- Demonstrate knowledge of an area of mathematics.
- Manage time, work to deadlines and prioritise workloads

SYLLABUS

The conceptual aspects of mathematics:

- What is mathematics? Mathematics in history and contemporary mathematics.
- Reasoning and logic. What is an argument? The notion of proof in mathematics with simple first examples such as the irrationality of √2, the triangle theorem, Pythagoras’ theorem, and the proof that there are infinitely many
primes.
- Abstraction and rules. The meaning of key algebraic terms such as: associativity, commutativity, distributivity, identity, inverse. The rules of high-school algebra. Proof that $-1 \times -1 = 1$.
- Problem-solving.
- The need for checking.

1. Combinatorics:
   - Counting
   - Manipulate sets and their elements. This includes the Boolean operations and set product.
   - Answer simple counting questions involving permutations and combinations. Connections with probability touched on.
   - Statement and proof of the Binomial theorem (by a counting argument). Applications.

2. Complex numbers and polynomials:
   - How complex numbers were discovered.
   - Add, subtract, multiply and divide complex numbers.
   - Find square roots of complex numbers.
   - Solve quadratics by completing the square.
   - Represent complex numbers in the complex plane.
   - Understand the geometric interpretations of addition and multiplication of complex numbers.
   - Proof that a polynomial of degree $n$ over the complex numbers has at most $n$ roots.
   - The fundamental theorem of algebra.
   - Proof of the fundamental theorem of algebra for real polynomials.
   - Find $n$th roots.
   - Use De Moivre's theorem to find expressions for $\sin n\theta$ and $\cos n\theta$.
   - Euler's theorem and its proof.
   - Find rational roots of polynomials with integer coefficients.
   - Factorize real and complex polynomials appropriately.
   - Understand the difference between trigonometric solutions and radical solutions.

3. Matrices:
   - Why matrices are important.
F17CC Introduction to University Mathematics

- Add, subtract, and multiply two matrices, and multiply a matrix by a scalar; be able to carry out sequences of such operations to obtain a single matrix as a result. The main emphasis will be on 'small' matrices often 2×2 or 3×3 throughout.
- Proof of associativity for matrix multiplication.
- Solve linear equations using Gaussian elimination.
- Proof of the fundamental theorem of linear equations.
- Compute determinants by first row expansion.
- Compute matrix inverses using the adjugate method.
- Calculate the characteristic polynomial of a matrix.
- Statement of the Cayley-Hamilton theorem and proof in the 2×2 case.

4. Vectors:

- What is Euclidean geometry?
- Compute with vectors using inner products, vector products, and scalar triple products.
- Find the equation of the unique line determined by two points or a point and a vector in space.
- Find the equation of the unique plane determined by three points or by a point and a normal.
- Calculate intersections of lines or planes.
- Derivation of the volume of a parallelepiped using scalar triple products and connection with determinants.

**COURSE RELATIONSHIPS**

N/A

**LOCATION AND ASSESSMENT METHODS**

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