# Unit 14: Maths for Computing

**Unit code** R/618/7421

**Unit level** 4

**Credit value** 15

## Introduction

In 1837, English mathematicians Charles Babbage and Ada Lovelace in collaboration, described a machine that could perform arithmetical operations and store data in memory units. This design of their ‘Analytical Engine’ is the first representation of modern, general-purpose computer technology. Although modern computers have advanced far beyond Babbage and Lovelace’s initial proposal, they still rely fundamentally on mathematics for their design and operation.

This unit introduces students to the mathematical principles and theory that underpin the computing curriculum. Through a series of case studies, scenarios and task-based assessments, students will explore number theory in a variety of scenarios; use applicable probability theory; apply geometrical and vector methodology; and, finally, evaluate problems concerning differential and integral calculus.

Among the topics included in this unit are: prime number theory, sequences and series, probability theory, geometry, differential calculus and integral calculus.

On successful completion of this unit, students will have gained confidence in the mathematics that is needed in other computing units. They will have developed skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

 

## Learning Outcomes

By the end of this unit students will be able to:

LO1 Use applied number theory in practical computing scenarios

LO2 Analyse events using probability theory and probability distributions

LO3 Determine solutions of graphical examples using geometry and vector methods

LO4 Evaluate problems concerning differential and integral calculus.

## Essential Content

### LO1 Use applied number theory in practical computing scenarios

*Number theory:*

Converting between number bases (denary, binary, octal, duodecimal and hexadecimal).

Prime numbers, Pythagorean triples and Mersenne primes. Greatest common divisors and least common multiples.

Modular arithmetic operations.

*Sequences and series:*

Expressing a sequence recursively.

Arithmetic and geometric progression theory and application. Summation of series and the sum to infinity.

### LO2 Analyse events using probability theory and probability distributions

*Probability theory:*

Calculating conditional probability from independent trials. Random variables and the expectation of events.

Applying probability calculations to hashing and load balancing.

*Probability distributions:*

Discrete probability distribution of the binomial distribution.

Continuous probability distribution of the normal (Gaussian) distribution.

### LO3 Determine solutions of graphical examples using geometry and vector methods

*Geometry:*

Cartesian co-ordinate systems in two dimensions. Representing lines and simple shapes using co-ordinates. The co-ordinate system used in programming output device.

*Vectors:*

Introducing vector concepts.

Cartesian and polar representations of a vector. Scaling shapes described by vector co-ordinates.

LO4 **Evaluate problems concerning differential and integral calculus**

*Differential calculus:*

Introduction to methods for differentiating mathematical functions. The use of stationary points to determine maxima and minima.

Using differentiation to assess rate of change in a quantity.

*Integral calculus:*

Introducing definite and indefinite integration for known functions. Using integration to determine the area under a curve.

Formulating models of exponential growth and decay using integration methods.

## Learning Outcomes and Assessment Criteria

| Pass | Merit | Distinction |
|---|---|---|
| **LO1** Use applied number theory in practical computing scenarios | | |
| **P1** Calculate the greatest common divisor and least common multiple of a given pair of numbers.<br><br>**P2** Use relevant theory to sum arithmetic and geometric progressions. | **M1** Identify multiplicative inverses in modular arithmetic. | **D1** Produce a detailed written explanation of the importance of prime numbers in the field of computing. |
| **LO2** Analyse events using probability theory and probability distributions | | |
| **P3** Deduce the conditional probability of different events occurring in independent trials.<br><br>**P4** Identify the expectation of an event occurring from a discrete, random variable. | **M2** Calculate probabilities in both binomially distributed and normally distributed random variables. | **D2** Evaluate probability theory to an example involving hashing and load balancing. |
| **LO3** Determine solutions of graphical examples using geometry and vector methods | | |
| **P5** Identify simple shapes using co-ordinate geometry.<br><br>**P6** Determine shape parameters using appropriate vector methods. | **M3** Evaluate the co-ordinate system used in programming a simple output device. | **D3** Construct the scaling of simple shapes that are described by vector co-ordinates. |

| Pass | Merit | Distinction |
|---|---|---|
| **LO4** Evaluate problems concerning differential and integral calculus | | **D4** Justify, by further differentiation, that a value is a minimum. |
| **P7** Determine the rate of change in an algebraic function.<br>**P8** Use integral calculus to solve practical problems involving area. | **M4** Analyse maxima and minima of increasing and decreasing functions, using higher order derivatives. | |

## Recommended Resources

### Textbook

Stroud, K. A. (2009) *Foundation Mathematics*. Basingstoke: Palgrave Macmillan.

### Journal

*Journal of Computational Mathematics.* Global Science Press.

### Links

This unit links to the following related units:

*Unit 18: Discrete Maths*

*Unit 33: Applied Analytical Models.*

 