Unit 17: Data Representation and Manipulation for IT

Unit code: D/601/3206

QCF Level 2: BTEC Specialist

Credit value: 7

Guided learning hours: 60

Aim and purpose

This unit introduces mathematical concepts (number and co-ordinate systems, functions and Boolean algebra) and their application to the development of computer programs.

Unit introduction

In order to work effectively as an IT professional, individuals need to have mathematical knowledge and be able to apply it. This unit gives an introduction to a number of key mathematical ideas, gives opportunities to develop useful skills and techniques and to be able to apply them in different areas of IT.

The unit starts with a look at real numbers and integers. The problems of expressing numbers in powers and scientific notation and the consequent errors due to rounding are addressed. The problem of holding these numbers in computer memory is also examined.

The unit then moves on to co-ordinate systems. Linear and polar co-ordinates and transformations are considered. The programming of vectors, offsets and scaling and the use of co-ordinate systems in output devices are an important part of this section.

The next part of the unit deals with equations. It starts with expressing problems as equations and then manipulating those equations to simplify them, it then moves on to methods of obtaining straight line equations from a graph.

Trigonometric and other functions are looked at next, mainly in the context of dealing with circles and triangles.

The final section of the unit is on Boolean algebra, dealing with binary states, truth tables and Boolean equations.

Learning outcomes and assessment criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

On completion of this unit a learner should:

Learning outcomes	Assessment criteria
1 Manipulate real numbers and integers	1.1 describe the difference between real numbers and integers 1.2 express numbers in power and scientific notation 1.3 perform arithmetic on numbers in power and scientific notation including multiplication and division of powers 1.4 round real numbers and estimate the resulting error 1.5 describe how real numbers and integers are represented in computer memory
2 Use co-ordinate systems and vectors, and linear transformations	2.1 describe two dimensional co-ordinate systems 2.2 represent simple shapes by finding the co-ordinates of the vertices 2.3 describe vectors 2.4 produce the polar representation of vectors 2.5 offset and scale shapes described by co-ordinates 2.6 convert between linear and polar co-ordinates 2.7 describe co-ordinate systems used in programming output devices
3 Use simple functions and basic algebraic operations	3.1 express simple problems as mathematical equations 3.2 simplify and change the subject of simple equations 3.3 describe the concept of a function 3.4 obtain the equation of a straight line from a graph 3.5 describe the basic properties of a circle and triangle 3.6 apply trigonometric and inverse functions
4 Apply Boolean algebra to problem situations	4.1 describe how binary states can be used to represent physical systems 4.2 identify and label the inputs and outputs of a binary representation 4.3 produce a truth table corresponding to a binary representation 4.4 express a truth table as a Boolean equation 4.5 simplify a Boolean equation using algebraic methods

Unit content

1 Manipulate real numbers and integers

Calculations: basic operations (addition, division, multiplication, subtraction) on number systems, on powers, using scientific notation; rounding errors; use brackets and the hierarchy of operations

Computer memory: representing integers and real numbers eg two's complement, Binary Coded Decimal; registers eg 8, 16, 32 bit

2 Use co-ordinate systems and vectors, and linear transformations

Co-ordinate systems: Cartesian, polar, Euclidian space, dimensions, axes, degrees, radians, applications of the two dimensional co-ordinate systems; conversions between linear and polar co-ordinates

Vectors: representation of a vector by a straight line, equal and parallel vectors, magnitude of a vector, vector addition and subtraction; representation of shapes by co-ordinates of vertices, offsets, scalar multiplication

Linear transformations: rotations, reflections, translations, inverse transformations

3 Use simple functions and basic algebraic operations

Definition: dependent and independent variable; inputs (domain); outputs (range); notation y=f(x); types: linear; quadratic; trigonometric; examples eg y = mx+c, y=ax2 + bx + c; simple trig functions and their inverses; linear functions and their inverses

Applications and problem solving: eg if f denotes converting Fahrenheit to Centigrade then f-1 denotes converting Centigrade to Fahrenheit; distance as a quadratic function of time in Newton's Laws of Motion; alternating current as a sine curve; calculating orbital speeds of satellites/finding geostationary points;

Properties of geometric shapes: circle, relationships between diameter, circumference and radius, tangent, area, description in Cartesian and polar co-ordinate systems; triangle, types (equilateral, isosceles, scalene, right angled), interior and exterior angles, area calculations, describing a triangle with vectors and co-ordinates

Graphs: using software to represent linear, quadratic and trig graphs eg spreadsheet, graphics package; obtaining straight line equations from a graph

4 Apply Boolean algebra to problem situations

Boolean operations: AND; OR; NOT; conjunction; disjunction; negation or complement; logic gates; truth tables; Venn diagrams for logic gates

Digital electronics: representing binary states as two voltage levels; use of logic gates in integrated circuits

Essential guidance for tutors

Delivery

It is likely that learners will come to this unit with a wide variety of prior knowledge and experience. For this reason it is suggested that the unit be delivered flexibly using workshops. This allows all learners to progress and accumulate expertise at different rates and to a different extent.

Necessarily, much of the content at this level is theoretical. Learners might not understand some of the practical applications until they study them at a higher level. Where possible, connections with IT-related applications should be made to provide the context for exercises and assignments. It is recommended that any data sets provided should relate to real-life scenarios.

A comprehensive initial assessment will identify the extent of each learner's prior skills and understanding and this could form the basis for a system that tracks each learner's skills and knowledge development. The content for the tracking system should include at least the content of this unit, however it is important that any other mathematical programmes that learners are undertaking are also taken into account and connections made with other teachers or lecturers as required. Regular formative assessment is necessary and this could be facilitated by IT systems.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments. The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to the unit
Manipulate real numbers and integers: • whole-class exercise – tutor presentation on the use of mathematics in a range of different situations, followed by individual exercises • whole-class exercise – tutor presentation on the use of powers and scientific notation in a range of different situations, followed by individual exercises • whole-class exercise – tutor presentation on the representation of numbers in computer memory, followed by individual exercises
Assignment 1 - Calculations and errors **Assignment 2** - Representing numbers
Use co-ordinate systems and vectors, and linear transformations: • whole-class exercise – tutor presentation on co-ordinate systems, including their use in describing shapes, followed by practical exercises • whole-class exercise – tutor presentation on vectors, including polar representation, followed by practical exercises • whole-class exercise – tutor presentation on offsets and scaling, followed by practical exercises • whole-class exercise – tutor presentation on the use of co-ordinate systems in programming, followed by practical exercises
Assignment 3 - Being co-ordinated
Use simple functions and basic algebraic operations: • whole-class exercise – tutor presentation on the use of equations, including functions, in a range of different situations, followed by individual exercises • whole-class exercise – tutor presentation on finding equations from straight line graphs, followed by individual exercises • whole-class exercise – tutor presentation on the properties of circles and triangles, followed by individual exercises • whole-class exercise – tutor presentation on trigonometric functions, followed by individual exercises
Assignment 4 - The correct function

Topic and suggested assignments/activities and/assessment
Apply Boolean algebra to problem situations: • whole-class exercise – tutor presentation on types of Boolean operations, followed by individual exercises • whole-class exercise – tutor presentation on Venn diagrams, followed by individual exercises • individual exercise – learners research the use of Boolean operations in digital electronics
Assignment 5 -The logical choice

Assessment

It is suggested that this unit is assessed using five assignments as summarised in the *Programme of suggested assignments* table.

Finding a scenario which covers all aspects of all criteria is difficult, but the one suggested in the programme of suggested assignments table is acceptable. It may be appropriate to use prepared exercises to provide evidence for some of the criteria in this unit, but it is recommended that, where possible, these be set to a vocational context. Exercises could be included in one or more assignments to be completed to a deadline, but centres are advised that timed tests or examinations would be outside the scope of the unit, which does not require calculations to be completed against the clock.

Any exercises used must be assessed by the tutor against the relevant criteria in the learning outcomes and assessment criteria table, informed by the range of unit content and must not be marked in terms of numerical (eg x/10) or percentage achievement. Where the unit content asks for a particular set of calculations to be completed, then all calculations must be completed successfully and it is expected that workings be shown where appropriate. Care must be taken that activities are completed individually and that there is no scope for the sharing of answers between learners.

It is inevitable that much of this unit will be evidenced on paper or using a spreadsheet but, where possible, centres are encouraged to vary strategies to include verbal presentations, posters and other forms of visual evidence and to set activities within a vocational context.

Where descriptive or explanatory evidence is required by a particular criterion, appropriate observation records completed by both the learner and tutor can form part of the evidence.

All four learning outcomes could be assessed in a similar way, with learners producing material for technical audiences specified by learners or the tutor.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass criteria in the outcomes and assessment grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment methods
1.1–1.4	Calculations and errors	A company has asked you to put together a brief guide to calculations, giving worked examples. The company would like you to support your brief guide by demonstrating how calculations can solve problems and how errors can occur.	Booklet. Posters. A set of mathematical tasks.
1.5	Representing numbers	The company asks you to extend your guide by including a section that shows how some of the calculations would be represented in computer memory.	Booklet. Posters.

Criteria covered	Assignment title	Scenario	Assessment methods
2.1–2.7	Being co-ordinated	A company has asked you to put together a brief guide to coordinate systems. The guide should include sections on linear and polar co-ordinates, transformations and the practical use of co-ordinates in computer applications.	Booklet. Posters. A set of mathematical tasks.
3.1-3.6	The correct function	The company now asks you to put together a brief guide to the type of functions that would be useful in representing data in charts. The guide should include a section explaining the significance and use of inverse linear and trig functions. The company would like you to support your guide by demonstrating how the functions are used in a software package such as a spreadsheet.	Booklet. Posters. A set of mathematical tasks.
4.1–4.5	The logical choice	The company would now like you to put together a presentation on Boolean operations and how they are used in digital devices. The firm would like you to demonstrate the use of logic gates and truth tables.	Booklet. Posters. A set of mathematical tasks.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC in IT sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Mathematics for IT	Advanced Data Representation and Manipulation for IT
		Mathematics for IT Practitioners

This unit maps to some of the underpinning knowledge from the following areas of competence in the Level 2 National Occupational Standards for IT (ProCom):

4.2 Data Analysis.

Essential resources

Learners will need access to a computer with a spreadsheet package.

Graphing facilities, capable of satisfying the learning outcomes described, will need to be available if not provided by the spreadsheet.

A good range of case study examples and exercises is needed.

Indicative reading for learners

Textbooks

Cameron P - *Introduction to Algebra – 2nd edition* (OUP Oxford, 2007) ISBN-10: 0198527934 ISBN-13: 978-0198527930

Johnston-Wilder S (Editor), Professor Mason J (Editor) – *Developing Thinking in Geometry* (Sage Publications Ltd, 2005) ISBN-10: 1412911699 ISBN-13: 978-1412911696

Lawler G – Algebra: *Basic Algebra Explained* (Studymates LTD, 2005) ISBN-10: 1842850687 ISBN-13: 978-1842850688

Lawler G – *Understanding Maths: Basic Mathematics Explained – 3rd edition* (Aber Publishing, 2007) ISBN-10: 1842850865 ISBN-13: 978-1842850862

Websites

mathworld.wolfram.com

tutorial.math.lamar.edu

Functional Skills – Level 2

Skill	When learners are …
ICT - Developing, presenting and communicating information	
combine and present information in ways that are fit for purpose and audience	creating presentations on mathematical topics
Mathematics - Analysing	
apply a range of mathematics to find solutions	demonstrating how functions and equations can be used to solve mathematical problems
Mathematics - Interpreting	
interpret and communicate solutions to multistage practical problems in familiar and unfamiliar contexts and situations	when creating presentations to illustrate mathematic procedures.