Unit 26: Mathematics for IT Practitioners

Unit code: L/601/7655

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to develop learner skills in mathematical techniques, including matrices, series and probability. Learners will also apply number systems including binary and hexadecimal and interpret data they have gathered for a defined purpose.

Unit introduction

Learners will gain an understanding of the mathematics needed, along with experience of applying mathematics to IT problems using techniques encompassing basic arithmetic to the collating and interpretation of larger datasets. This will provide a base for learners to enhance their current skills and then apply them to other areas of the course, such as programming or networking. Learners will discover the use of analytical skills in order to apply them to realistic IT problems.

This unit starts by exploring matrices and looks at how they relate to arrays as used in programming. This is followed by sequences and series, probability and recursion. Recursive algorithms are investigated in areas such as sorting and searching for data. Number systems, including binary and hexadecimal are investigated along with their application in areas such as Multipurpose Internet Mail Extensions (MIME) and IP addressing. Finally, the gathering and interpretation of data is carried out in the context of statistically analysing data for a defined purpose.

Learning outcomes

On completion of this unit a learner should:

1 Be able to apply matrix methods

2 Be able to apply sequences and series, probability and recursion

3 Be able to apply number systems

4 Be able to interpret data.

Unit content

1 Be able to apply matrix methods

Matrices: method of representing ordered data; relationship with computer program variable arrays; index notation

Operations: add, subtract, scalar multiplication; multiply two matrices; inverse; transpose

Techniques: solving simultaneous linear equations; vector transformation and rotation; maps and graphs

2 Be able to apply sequences and series, probability and recursion

Sequences and series: nth term of a sequence; generation of recurrence relationship; arithmetic and geometric sequences and series; sum to n terms of an arithmetic and geometric series; sum to infinity of a geometric series; Σ notation

Probability: events eg union, intersection, complementary, mutually exclusive, independent; space diagrams eg sum of scores when two dice are thrown; visualising events using Venn diagrams; tree diagrams

Recursion: series eg Fibonacci, factorial, natural numbers; termination condition; recursive algorithms eg factorial, quicksort, binary search

3 Be able to apply number systems

Number systems: binary, octal, denary and hexadecimal; conversion between number systems; basic operations eg addition, division, multiplication, subtraction on number systems

Applications: eg ASCII code (binary), MIME (hex), file permissions in Unix (octal); IP addressing v4 and v6; subnet addressing; subnet masking; class A, B and C addresses; Classless Inter Domain Routing (CIDR)

4 Be able to interpret data

Representing data: comparing data sets using back-to-back stem and leaf diagrams eg pulse rates of students before and after exercise; mean; median; mode; interquartile ranges; histograms; variance; standard deviation

Gathering data: methods of gathering quantity data eg measurements, questionnaires, surveys; extraction of required information from raw data; limitations of data gathered

Interpreting data: eg analysing summary data, proving hypotheses, identifying trends and patterns

Assessment and grading 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 for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 demonstrate how matrices can be used to represent ordered data	**M1** explain the relationship between matrices and computer program variable arrays	
P2 perform add, subtract and scalar multiplication operations on a matrix		
P3 multiply two matrices		
P4 find the inverse and transpose of a matrix		
P5 apply matrix techniques to solving simultaneous linear equations	**M2** apply matrix techniques to vector transformation and rotation, maps and graphs	
P6 apply sequence and series, probability and recursion techniques to develop solutions to a range of problems	**M3** explain the stages of a recursive algorithm showing how the termination condition is reached	
P7 carry out basic operations on number systems		
P8 carry out conversion operations between number systems	**M4** discuss how number systems are used in IT applications	**D1** design an addressing scheme for a network with multiple subnets, utilising CIDR, justifying your choices
P9 plan for and gather data for defined purpose		
P10 interpret trends and/or patterns in data. [IE6]	**M5** recognise the factors influencing the validity of information derived from collected data. [SM4]	**D2** reflect on the results of a study that involved the collection and analysis of data. [RL3]

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators

Essential guidance for tutors

Delivery

The learning outcomes could be delivered in the order presented, however some of the content relates to isolated sets of skills and knowledge and the order could be varied.

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 is the unit is flexibly delivered using workshops. This allows all learners to progress and accumulate expertise at different rates and to a different extent.

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

For LO1 it is important to relate the use of matrices to IT, for example in areas such as computer graphics where matrices can be used to project three-dimensional objects onto two-dimensional computer screens and in electronics where circuit components and their input/output voltages and resistance can be represented by matrices.

LO2 leads to recursion and recursive algorithms used in programming. Examples include calculating factorials and using search and sort programmes. These could be demonstrated using an appropriate programming language or using pseudo code.

LO3 covers number systems and their application in areas such as MIME encoding and IP addressing. The latter could be covered by exploring, for example, their internal centre network and the addressing scheme, subnet addresses and subnet masks that are used.

LO4 is about gathering and interpreting data using a range of methods. This might involve gathering more than one data set. For example, using supplied data about a group before and after they went on a diet, to interpret this data using back-to-back stem and leaf diagrams; then carrying out measurements on a group of learners and using histograms, variance and standard deviation to interpret the data. Learners should be made aware of the different types of software that could be used to interpret the data and these should be demonstrated and used if available.

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 matrices, operations. Use in simultaneous equations, transformations and rotations, maps and graphs. Relating use to IT, eg computer graphics, electronics.
Introduction to sequences and series including APs and GPs. Introduction to probability, Venn diagrams, tree diagrams. Introduction to recursion; factorial notation; search and sort programmes. Use of pseudo code or programming languages to demonstrate algorithms.
Introduction to number systems; converting between number systems, eg decimal to binary/octal/hex; operations on number systems, eg adding binary/octal/hex numbers. Applications of number systems, eg ASCII, IP addressing.
Introduction to representing data; stem and leaf diagrams; median; mode; interquartile ranges; histograms; variance; standard deviation. Introduction to gathering data, eg surveys, measurements, questionnaires. Interpreting data, eg using spreadsheet, tables, graphs.

Assessment

To achieve a pass grade, learners must meet the criteria listed in the assessment and grading criteria. P1-P8 could be given as a series of tasks or exercises.

P9-P10 could be based on a small-scale project involving the learners planning and gathering information for a particular purpose, for example based on height/weight/journey time/pulse rates/exam marks etc.

To achieve a merit grade, learners must meet all of the pass grade criteria and all of the merit grade criteria. M1 could be explained with reference to a specific programming language or using pseudo code. M2 could be evidenced by a series of examples. M3 could be explained by using, for example, the quicksort algorithm, either in a programming language or in pseudo code, detailing how the recursive calls lead to a sorted set of data and explaining why the process terminates at a certain point. M4 is a discussion about the application of binary, octal and hex number systems in different areas of IT and while some examples are given in the content, learners should be encouraged to research a wide range of examples to make this section meaningful. M5 is an extension of P10 and requires an evaluation of the limitations of the data set they have chosen to gather.

D1 could be dealt with by giving learners a case study of a network with, say, three subnets containing 1000, 200 and 30 hosts respectively and getting them to design subnet addresses and masks to optimise the allocation of IP addresses. D2 is an extension of M5 and could be dealt with by discussing the results of the study.

Links to other BTEC units

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

Level 1	Level 2	Level 3
		Unit 6: Software Design and Development
		Programming units 14-16

Essential resources

Textbooks and/or worksheets with a wealth of examples that learners can utilise.

Employer engagement and vocational contexts

In supporting the outcomes from other units, this unit can be used to support the creation of a software application in a vocational context where part of the application may use one (or more) of the mathematical outcomes from this unit.

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are …
Independent enquirers	analysing and evaluating information, interpreting trends in data
Reflective learners	reviewing progress, acting on the outcomes of the results of a study.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are …
Independent enquirers	creating and identifying questions to answer to resolve a range of maths problems.

Functional Skills – Level 2

Skill	When learners are …
Mathematics – Representing	
Choose from a range of mathematics to find solutions	interpreting trends and/or patterns in data; recognising the factors influencing the validity of information derived from collected data; reflecting on the results of a study that involved the collection and analysis of data
Mathematics – Analysing	
Apply a range of mathematics to find solutions	demonstrating how matrices can be used to represent ordered data; performing add, subtract and scalar multiplication operations on a matrix; multiplying two matrices; finding the inverse and transpose of a matrix; applying matrix techniques to solving simultaneous linear equations; applying sequence and series, probability and recursion techniques to develop solutions to a range of problems; carrying out basic operations on number systems; carrying out conversion operations between number systems
Mathematics – Interpreting	
Interpret and communicate solutions to multistage practical problems in familiar and unfamiliar contexts and situations	demonstrating how matrices can be used to represent ordered data; performing add, subtract and scalar multiplication operations on a matrix; multiplying two matrices; finding the inverse and transpose of a matrix; applying matrix techniques to solving simultaneous linear equations; applying sequence and series, probability and recursion techniques to develop solutions to a range of problems; carrying out basic operations on number systems; carrying out conversion operations between number systems
Draw conclusions and provide mathematical justifications	demonstrating how matrices can be used to represent ordered data; performing add, subtract and scalar multiplication operations on a matrix; multiplying two matrices; finding the inverse and transpose of a matrix; applying matrix techniques to solving simultaneous linear equations; applying sequence and series, probability and recursion techniques to develop solutions to a range of problems; carrying out basic operations on number systems; carrying out conversion operations between number systems.